MAY 1959

Power Engineering

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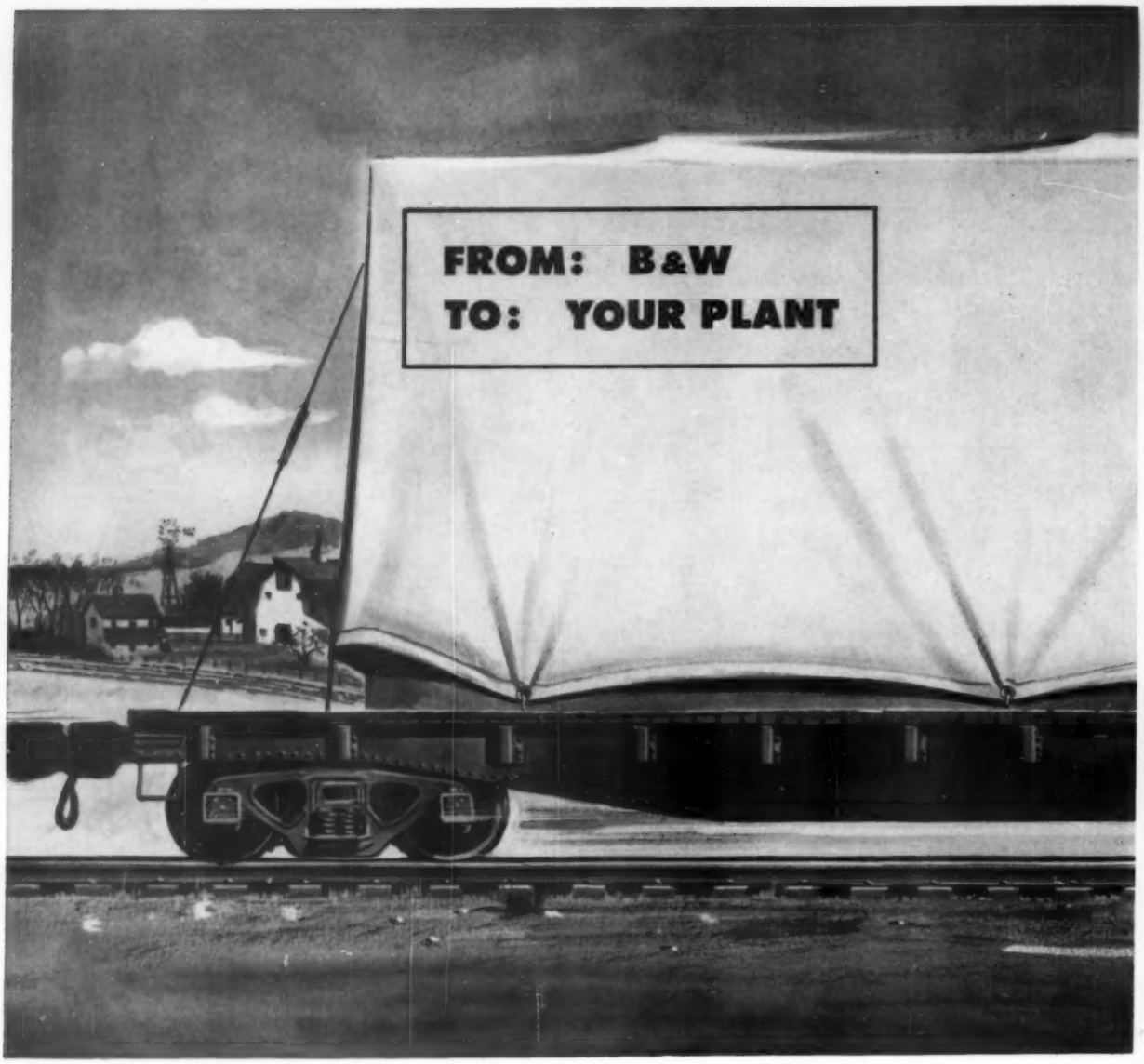
Circulation of This Issue 42,820



Do you need from 60,000 to 100,000 pounds of steam per hour? Have it delivered to your plant in one space-saving, dependable and economical package—the B&W Type FO Package Boiler for oil and gas firing.

What does the B&W Type FO Package Boiler offer you?

Superior Performance—Capacity up to 100,000 lb/hr. Steam pressures from 250 to 775 psi. Temperatures to 750 F. The B&W Type FO Package Boiler gives you ample furnace volume and area in a really compact unit. It's the result of B&W's years of designing for reliable high capacity in small space for the Navy and Merchant Marine.

Dependability—The entire furnace is water-cooled. That means less trouble; low maintenance. Also, the drainable superheater allows fast start-up and safe, rapid storage.

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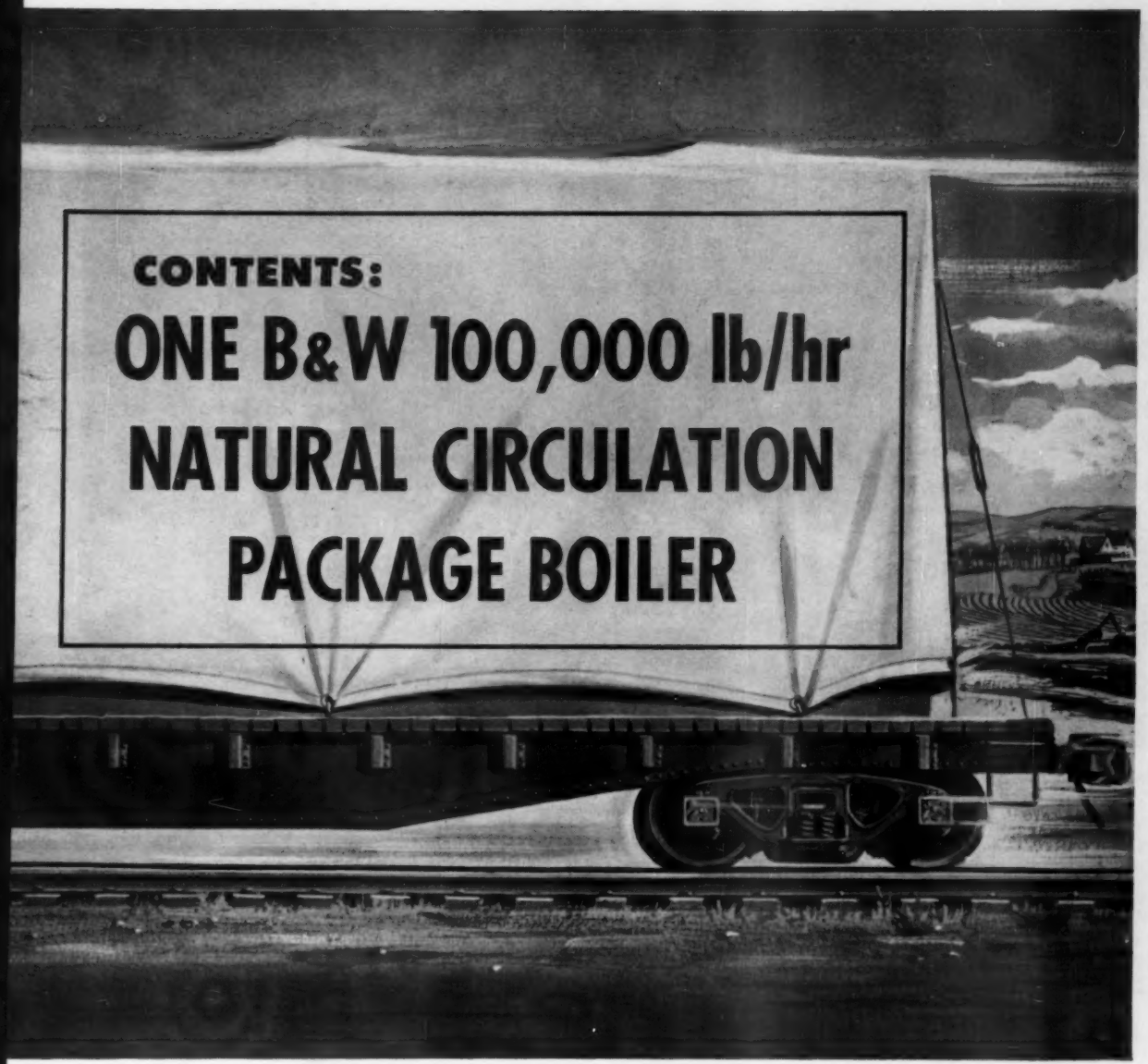
Natural Circulation—It's the best way to bring you maximum reliability, simplicity, and minimum maintenance at low cost.

Clean, Dry Steam—B&W Cyclone Steam Separators and Scrubbers guarantee minimum carry-



over, maximum circulation. Thousands of boiler installations have proved the superiority of Cyclone Separators.

Easy Installation—Remove it from the flatcar, make a few connections, start it up.

Three words sum up the advantages of the new B&W Type FO Package Boiler—*economy, convenience, quality.*

Get the complete details on the natural circulation, oil and gas fired B&W Type FO Package Boiler, from your local B&W Sales Engineer. Or write The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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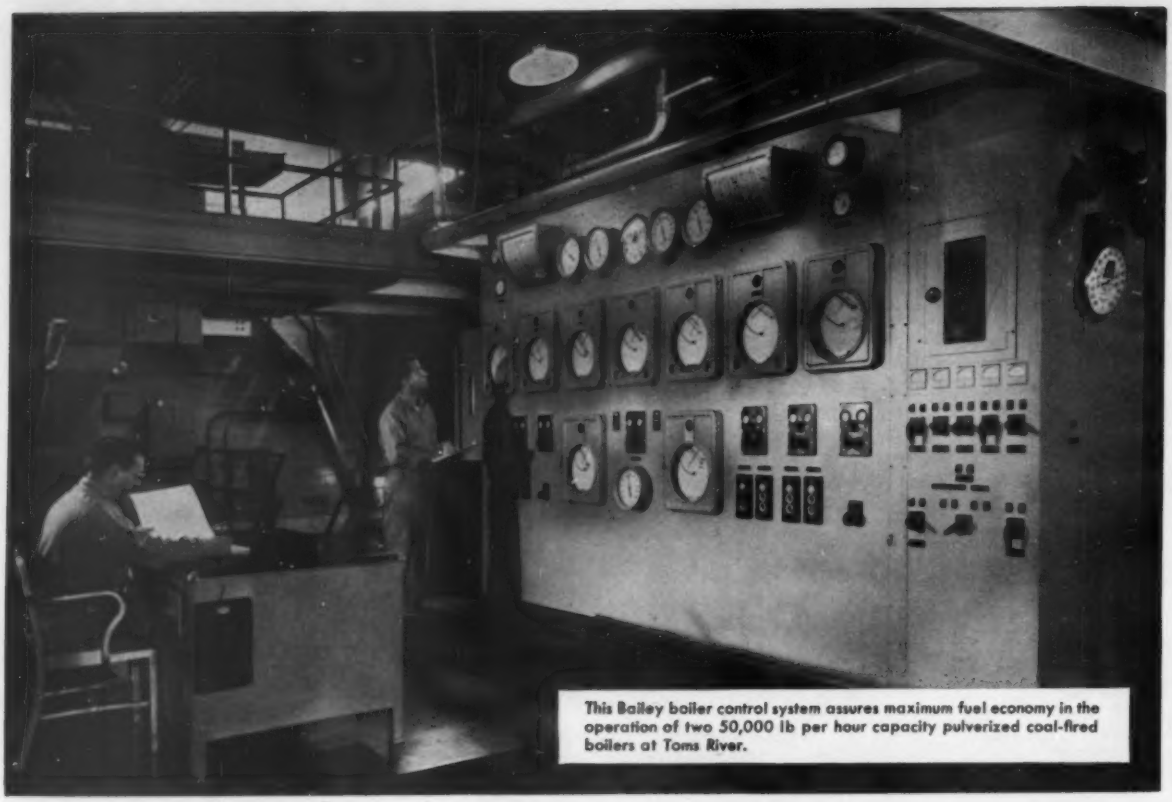

This Bailey boiler control system assures maximum fuel economy in the operation of two 50,000 lb per hour capacity pulverized coal-fired boilers at Toms River.

How Bailey helps control STEAM COSTS AT TOMS RIVER

With a Bailey-engineered control system you can count on a high output of available energy per unit of fuel, whether you operate a small industrial boiler or a large central station boiler.

They did at Toms River — Cincinnati Chemical Corporation's plant in Toms River, N. J.! Bailey Controls help them save fuel by continuously maintaining desired operating conditions.

Most high-efficiency steam generating plants rely on Bailey because:

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Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion and automatic control are your assurance of the best possible system.

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Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

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308 E. JAMES ST., BARRINGTON, ILL.
DUnkirk 1-1840
Chicago NEwcastle 1-0488

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Change of Address: Send to POWER ENGINEERING, Circulation Division, Barrington, Illinois. Please supply your position title, company name, company address. Request must reach us by 15th of month to make the change effective with the following month's issue.

Subscription Information: Published monthly; price in U.S. and possessions $10 per year; in Canada $11 per year; other countries $12 per year; single copies $1.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Microfilm edition: Request prices from University Microfilms Inc. Ann Arbor, Mich. All volumes since 1948

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

TO HELP SOLVE the problem of producing electricity at a minimum cost, two leading U. S. companies have announced a joint program to develop and operate an advanced automatic control system masterminded by a digital computer. Collaborating in the venture are Philadelphia Electric Co and Minneapolis-Honeywell Regulator.

Scheduled to be placed in full operation by Philadelphia Electric by the end of 1960, the system will calculate the least expensive pattern of allocating generation to meet system demands; automatically assign this allocation to generating units; provide cost data for billing computation on the power exchanged with neighboring electric companies.

This is reportedly the first time that a digital computer designed specifically to be adaptable to industrial processes will be made an integral part of the control loop of a system which itself represents a significant advance in automatic control. Also, for the first time, basic data for interconnection billing will be computed simultaneously with control computations.

ABOUT MEETINGS: First convention of the National Industrial Association to be held outside the U. S. will meet in Montreal, May 17–20, at the Hotel Queen Elizabeth. President-elect of the electrical equipment service and sales operators is H. C. Blenkhorn, of Blenkhorn and Sawle, Ltd, of St. Catharines, Ontario.

AIEE'S Middle Eastern District Meeting will be held at the Hotel Lord Baltimore, Baltimore, Md, May 19–21. Dr. Paul A. Betz of Baltimore Gas & Electric Co is general chairman.

Design Engineering Conference and Show will be held in Convention Hall, Philadelphia, May 25–28. Conference is sponsored by the machine design division of ASME. More than 400 companies will exhibit.

Engineering Progress Exposition, sponsored by the National Society of Professional Engineers and the New York State Society of Professional Engineers, will be held June 17–20 at the Hotel Commodore in New York City.

Third annual meeting of the American Association of Cost Engineers will be held at Carnegie Institute of Technology in Pittsburgh, the week of June 21.

SAFETY citation has been given by Edison Electric Institute to the Essex electric distribution department of Public Service Electric and Gas Co of Newark, N. J. Reason: from a start on April 25, 1958, the department completed 1,000,000 manhours of work without a lost-time injury.

BUILDER of the big new United Engineering Center in New York City will be Turner Construction Co of New York. To be erected on the west side of United Nations Plaza between 47th and 48th Sts, the Center will be a $10,000,000 tower structure of 18 stories, with about 260,000 sq ft of floor space, and will house ten national engineering societies devoted to the advancement of engineering knowledge and practice. Together, they represent nearly 250,000 members in major fields of creative engineering.

Engineering Societies Library will also be housed in the Center, as will five joint groups dealing with engineering research and improved educational standards.

RUNDOWN on coal research during 1958 in the U. S. is given in the *Mining Congress Journal* for February, 1959. Projects are going forward at the following:

Alabama Power Co and Southern Research Institute; Alabama State Mine Experiment Station; American Gas Association; Babcock & Wilcox Co; Bituminous Coal Research, Inc; Christopher Coal Co and the West Virginia University Engineering Ex-

periment Station; Consolidation Coal Co; Eastern Gas and Fuel Associates, Inc, and Jeffrey Manufacturing Co; Illinois State Geological Survey; Island Creek Coal Co; Mellon Institute and the Coal Industry Advisory Committee of Ohio River Valley Water Sanitation Commission; Norfolk & Western Railway Co; North American Coal Corp; Ohio Geological Survey and Ohio State University; Pennsylvania State University; Pittston Co; Tennessee Valley Authority; Union Carbide Corp; United Engineers and Constructors, Inc; U. S. Bureau of Mines; University of Kentucky; University of Utah; Virginia Polytechnic Institute; West Virginia Geological and Economic Survey.

NEW, FREE price list of Atomic Energy Commission unclassified research reports for sale by the Office of Technical Services, U. S. Department of Commerce, is now available from OTS on request.

This cumulative listing of some 4000 AEC reports in the OTS collection includes new documents acquired since July, 1958. To obtain the new list, request AEC Research Reports Price List No. 31 from OTS, U. S. Department of Commerce, Washington 25, D. C.

Price lists are issued semi-annually, and the next list will be available in August. OTS also publishes U. S. Government Research Reports, a monthly publication which lists new research reports as soon as they are released by the AEC. It also describes reports from the Army, Navy, Air Force, and other Government agencies available to the public through OTS.

This publication may be obtained on a subscription basis from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at $6 a year.

CLEVELAND ELECTRIC Illuminating Co has put into operation a new G-E turbine generator at its Ashtabula Plant which represents 250,000 more kw on the company's lines. The generating unit, installed at a cost of $32,000,000, brings the company's total net generating capability at its four plants to 1,909,000 kw.

The new power producer doubles capacity at the Ashtabula Plant, yet it will consume only about two-thirds as much fuel as the other four generators combined.

Associated equipment, including the boiler and coal pulverizing mills, was manufactured by Combustion Engineering Co. The concrete stack is 400 feet high and contains nearly $1,000,000 worth of smoke-abatement and dust-control equipment.

QUARTER MILLION DOLLAR contract for controls, instrumentation and data processing equipment on the largest steam boiler in the world goes to Hagan Chemicals & Controls, Inc. It's the twin furnace unit for TVA's Widow's Creek Station in Stevenson, Ala, scheduled to go into service in mid-1960. Combustion Engineering is building the gigantic boiler which is rated at 3,850,000 lb of steam per hr and will power a turbine with an output of 500,000 kw.

COAL-BURNING GAS TURBINE, as feasible for power generation in a stationary plant, has been picked for research by the U. S. Bureau of Mines.

A stationary plant development program is planned for the Morgantown, W. Va., station of the Bureau and will take advantage of more than 12 years of research and development carried out by the Locomotive Development Committee of Bituminous Coal Research, Inc. The Committee is lending to the Bureau of Mines a full-size 4200-hp gas turbine installation valued at $1,200,000. The Committee's original objectives of proving the feasibility of a direct-fired coal-burning gas turbine are reported to have been successfully achieved.

The 4200-hp gas turbine plant has been operated more than 5000 turbine hours since 1950, and the Union Pacific Railroad has announced that they will build a coal-fired gas turbine locomotive, incorporating designs developed by the Locomotive Development Committee.

Bureau of Mines' work on the coal-burning gas turbine will be carried out in coöperation with industry. Under the Bureau's program, even better fly ash control will be sought, even though the Locomotive Development Committee has already attained dust collection efficiencies exceeding 92 per cent at high pressures and at elevated temperatures. The Bureau of Mines will work toward improving turbine blade design and improving materials in its attempt to extend blade life.

ABOUT PEOPLE: Fred W. Argue, engineering manager and a vice president of Stone & Webster Engineering Corp, has been named executive vice president. Alfred L. Hartridge, S&W treasurer and a vice president, has been named financial vice president, and will make his headquarters in New York City.

John Thornborrow has been appointed to succeed Walter B. Gesell as director of economics and statistics of the Edison Electric Institute. Thornborrow joins EEI after nine years as manager of public utility investments of the Northwestern Mutual Life Insurance Co.

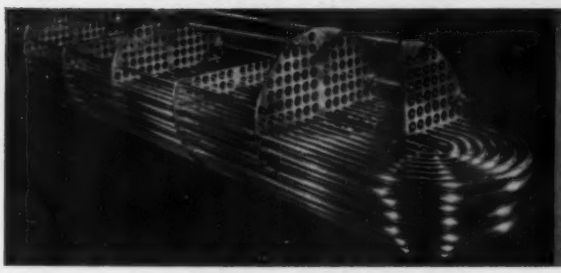
Grant O. Hylander has been named president of Ebasco International Corp, to succeed Henry B. Sargent, who was appointed chairman of the board of directors. Hylander was formerly EIC's executive vice president.

John R. Carlson, engineering manager, and Charles I. Mauntel, sales manager of the Westinghouse steam division, have received the company's highest honor — the Westinghouse Order of Merit.

AIEE's Lamme Gold Medal has been awarded jointly to Philip L. Alger of Schenectady, N. Y., and Sterling Beckwith of Lake Forest, Ill, "in recognition of their contributions to the arts and science of design and application of rotating electric machines." Alger recently retired from the General Electric Co, and Beckwith is a consulting engineer.

Recent changes in the POWER ENGINEERING staff include the following: Arthur L. Rice, Jr, is now serving as the company's executive vice president, as well as treasurer; Connie J. Grabb is the new district manager for the West Coast.

Bill Marshall is serving as editorial assistant. Chester R. Earle, POWER ENGINEERING'S editor, has been appointed to represent AIPE on the Water Policy Panel of EJC. He has also been nominated to represent AIPE on EJC committees on Honors for Engineers and Practice of Engineering.



CONDENSER AND HEAT EXCHANGER CLINIC

Edited by David S. Hibbard, Metallurgical Engineer
The American Brass Company, Buffalo 5, New York

New tube mill equipment gives designer of heat-transfer units freer hand in meeting new trends

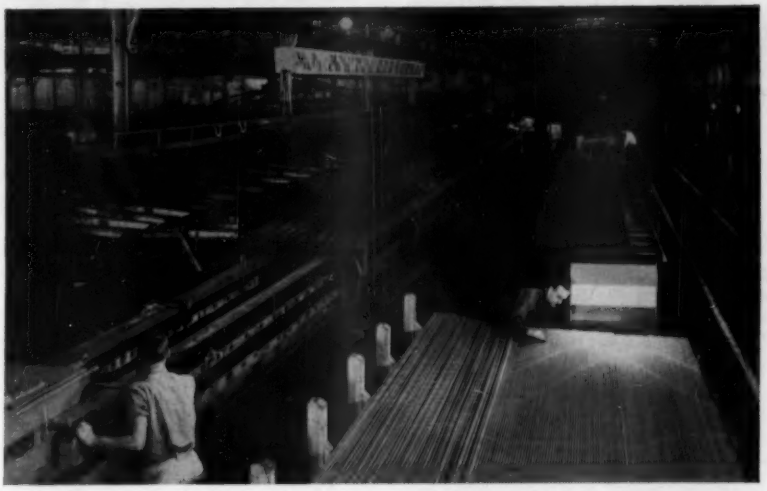
With the installation of new production and testing equipment, The American Brass Company now offers the most complete service available to users of condenser and heat exchanger tubes.

Long lengths. To gain advantages in construction, processing, or installation, designers can lengthen equipment considerably. Tubes can now be drawn up to 100 feet. Most of the longer tubes are required as U-bends, but in some instances may be shipped as straight lengths.

U-bends. Tubes from ⅜″ O.D. to 1½″ O.D. with wall thicknesses from .049″ (18BWG) to .134″ (10BWG) can be bent on a radius of from 1¼ times the tube O.D. to 30″.

Dual Gage. Where high temperatures and pressures are involved, it may be desirable to thicken the tube wall in the area of short-radius bends on U-bend tubes. Walls are thickened one Stubs' Gage No. to compensate for thinning of metal in the bending.

Thickened Tube Ends. To compensate for thinning by rolling or by impingement corrosion caused by high velocities, tubes may be supplied with the wall thickened at one end one or more Stubs' Gage Nos. The extra thickness may be on the outside or inside of the tube as required.



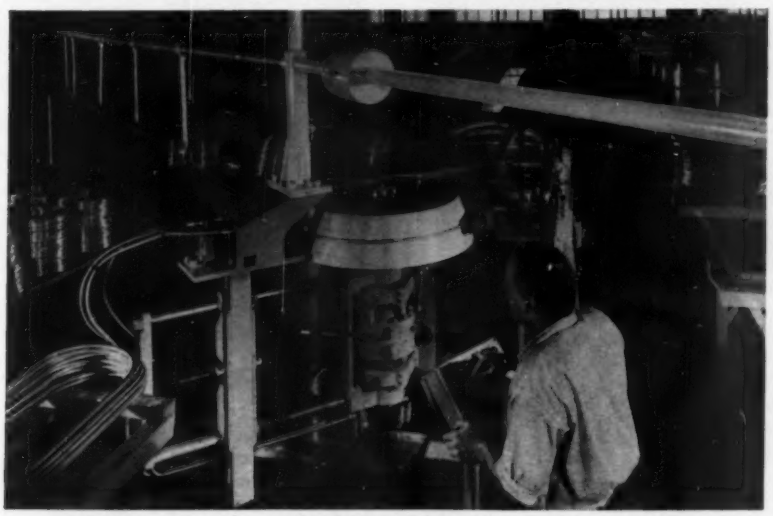
GENERAL VIEW of new American Brass Company equipment which can draw copper and copper alloy tubes in lengths up to 100 feet.

Relieving Stresses. All U-bend tubes, other than copper, are annealed at the bend area after bending, to eliminate the hazard of stress-corrosion cracking which might occur in service due to stresses that may exist as a result of the bending.

Testing. U-bends are tested hydrostatically at ASME Code pressures—or at pressures up to 6000 psi on request, if the tube size will stand it. Electronic inspection with eddy-current equipment is available also, when required.

Shipping. U-bend tubes are shipped packed for ease in handling and storage.

Technical Assistance. For more detailed information on extra-long tubes, U-bend, Dual-gage, or Duplex tubes to meet special problems, address: The American Brass Company, Buffalo Division, Buffalo 5, New York. In Canada: Anaconda American Brass Limited, New Toronto, Ont. 8967



BENDER CAN produce U-bend tubes with straight leg up to 50′ long.

ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Made by

The American Brass Company

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WHAT THEY TELL US

▶ **AUTHOR** Gordon H. Sandall of the article in our March issue describing how the Alpena (Mich) Power Co reduces maintenance and cuts outages by using a new silicone insulator compound, writes:

> The article was composed around a problem we had in our operating area, that we successfully solved by the use of silicone compound No. 5, and we felt that other utilities confronted with a like problem would be interested. We have already received inquiry from as far away as Louisiana.
>
> Again thanks very much for the splendid way in which the article was published.

▶ **DO TURBINE DRIVES** mean steam economy? We said yes in an article in a POWER ENGINEERING feature for February. Now we have this comment from A. A. Cummins, consulting engineer in Ann Arbor, Mich.

> . . . the title [of the article] might more nearly be true if it read, Turbine Drives Mean Steam Economy in Some Instances. It is our humble opinion, from many calculations made, that probably more often than not steam drives do not mean steam economy.
>
> If the aim is to generate power at a minimum cost and the plant owner has installed a large turbine from which he uses exhaust or extracted steam for processing, a thorough study will show that if the steam used to drive an auxiliary turbine is run through a large turbine (which is already running), the much higher efficiency of the large turbine will permit the generation of considerably more electricity than is required to motor drive a piece of equipment which might otherwise be driven by a small steam turbine.
>
> We have found cases in plants where old, small turbines were being used where this ratio was 8 to 1. We have never found it less than 2 to 1.
>
> On the other hand, if the manufacturer is not generating electric power, with steam going to the condenser, nor buying any electric power, nor exhausting steam to the atmosphere, then the use of the steam turbine would make no difference.
>
> This would occur when the steam demand is high in relation to the electrical requirements. Also, if he does not have a turbine generator, but is buying all electric power and can use exhaust steam from an auxiliary turbine in processing or heating, then its use becomes a distinct economy.

▶ **RECENT** publicity in the press stated that TVA had encountered "serious problems" with 14 turbine generators purchased from Westinghouse. A. C. Monteith, a Westinghouse vice-president, says:

> The turbine generators supplied to TVA were of advanced design and, when modifications now underway are completed, will be the most efficient for their temperatures and pressures on the TVA system.
>
> The TVA turbines were a pioneering effort because of their size and the temperatures and pressures at which they operate. The metallurgical problems encountered also have been solved through continued research. Modifications to correct these mechanical difficulties are well along, and will be completed by mid-1959.

▶ **FUEL FOR TOMORROW'S POWER** was a theme we explored in handy form in a two-page article in the December, 1958 issue. D. S. Taber, Twin Cities Engineer of the Industrial District for Socony Mobil Oil Co, writes:

> We would appreciate it if you would make available to us 30 additional copies of the article, Fuel for Tomorrow's Power, for use with our field marketing personnel, since we feel it gives them, in capsule form, an excellent picture of the current and projected power and energy demands.

The 30 copies have been dispatched to Reader Taber, with our compliments.

▶ **SNOW-MELTING PIT** for a large parking area is an idea which reader K. Hodges has on his mind. Maybe other readers are thinking about such a device, too. Hodges' problem is that the snow must be cleared off the parking space very rapidly, as fast as it accumulates; and if the winter is a hard one, such as the one we've just been through, where to put the snow is a real puzzler. Hodges says:

> I am considering the use of a large concrete pit in which will be installed coils carrying hot water. We would bulldoze the snow into the pit to melt it, and let the water run off into the sewer. The sewers are plenty big enough to take this run-off.
>
> But if we put hot water or steam or anything else into that concrete pit, will it not cause the concrete to crack? Temperature might go up as high as 140 F and down to about 40 F.

We wonder if the temperature range would really be as great as Hodges thinks, because no matter how hot the water and steam may be, the snow will immediately cool it down in the melting process. Also, a dry-mix concrete could be used, which will give a very hard wall, reinforced, of course, with steel or mesh.

What's your opinion?

▶ **ANOTHER WITNESS** eager to set L. E. Gile straight about the matter of hand-hole plates in hrt boilers (see this department for January) is James M. Curran of Desbiens, Quebec. He writes:

> L. E. Gile states that he has never heard of a hand-hole plate in an hrt boiler . . . I was a traveling engineer, and I have seen hrt boilers with only hand-hole plates, in the front, on the top of the shell and in the rear header.
>
> Prior to the year 1921, as K. D. Cilley explains, hand-holes were permitted, although I have inspected boilers dated 1922 with hand-holes in the top and directly in the front header.
>
> Today boilers are not constructed with hand-holes, except for vertical tubular boilers. Incidentally, I have inspected a boiler built in 1888, which makes it 71 years old. This B&W water tube boiler was built for 300-lb pressure, but operates at 10 per cent — 30 lb — to heat a large office building.
>
> Are there any readers who have seen boilers older than this?

In Los Angeles recently, at the Space Age Conference, M. A. Nishkian, well-known consulting engineer, equipped his firm's booth with reprints of an article from POWER ENGINEERING for distribution to visiting industrialists

Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.

The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

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You get these benefits YARWAY GUN-PAKT

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

- **CONTINUOUS SERVICE**

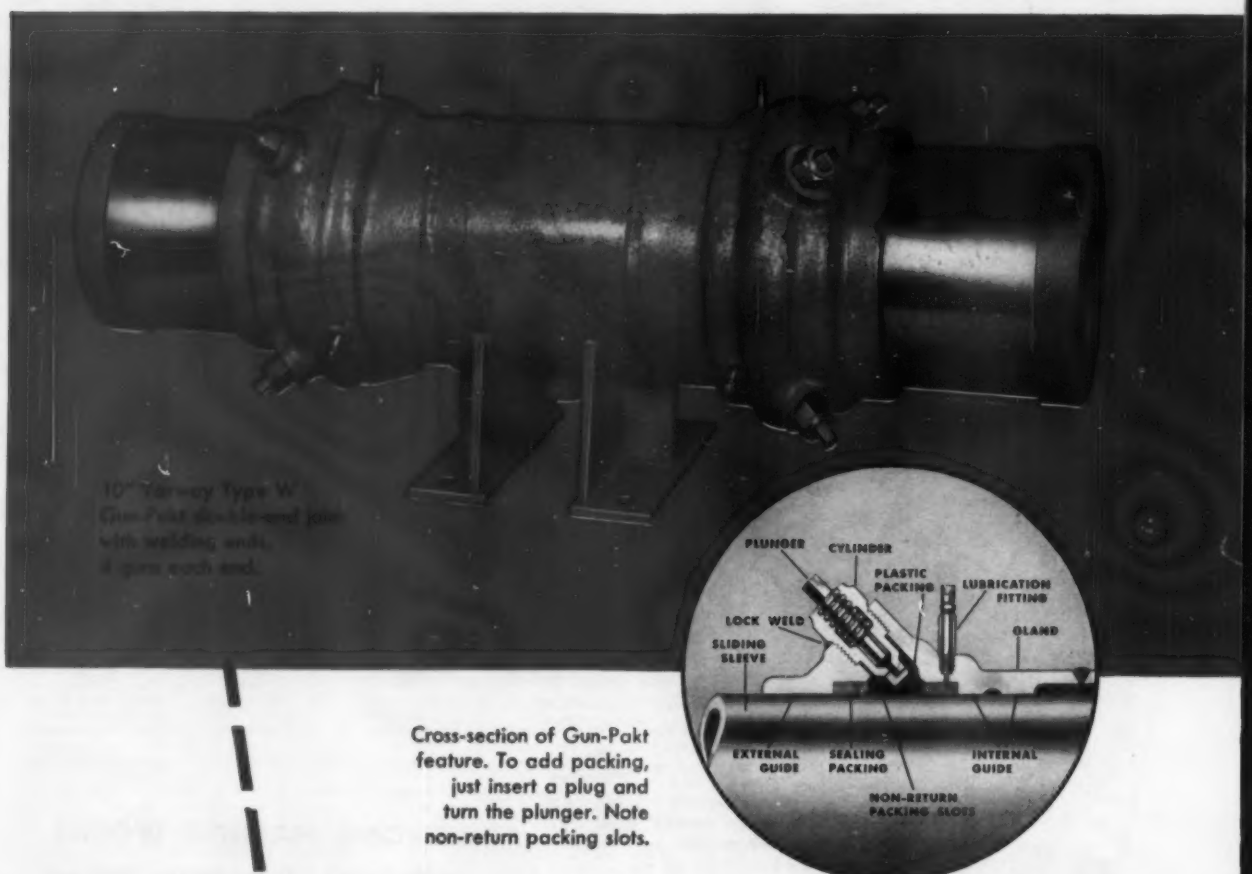
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure.* No vents are necessary. Never needs repacking.

- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**

  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue.* Wrought steel bases provide rugged, positive anchorage.

- **INTERNAL AND EXTERNAL GUIDES**

  Positive alignment of sleeve in stuffing box—*where it counts!*



Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

when you install EXPANSION JOINTS

- **LIGHT WEIGHT, STREAMLINED DESIGN**

  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance* —no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

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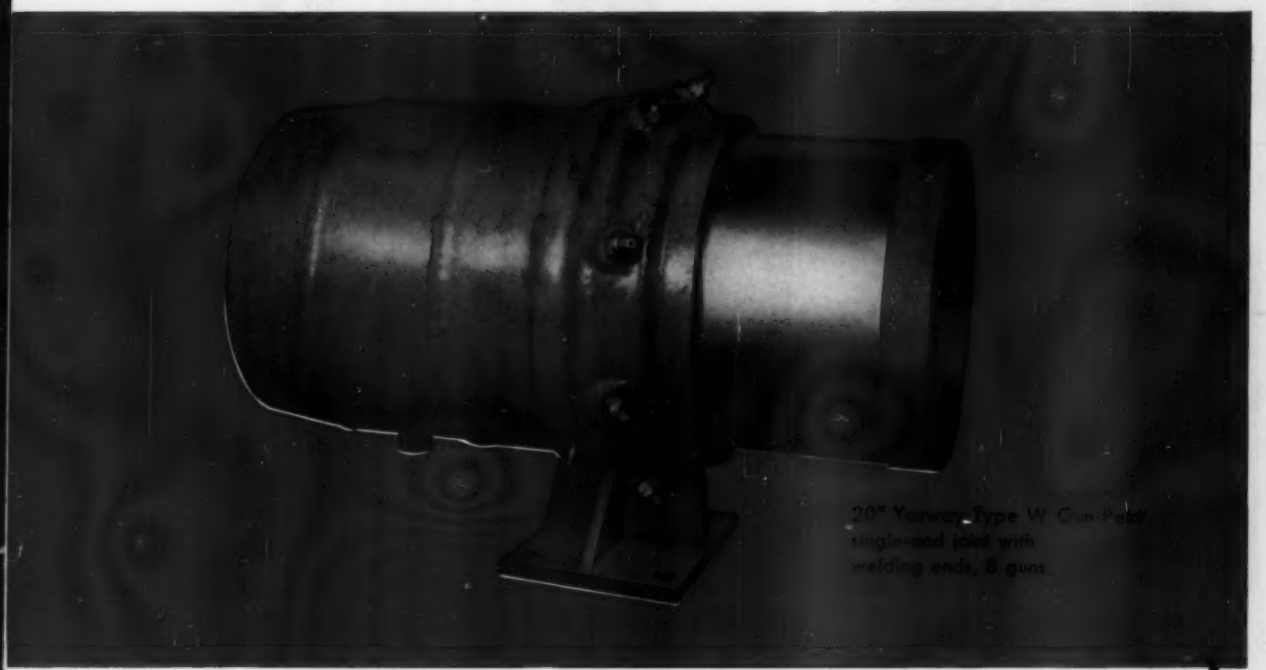
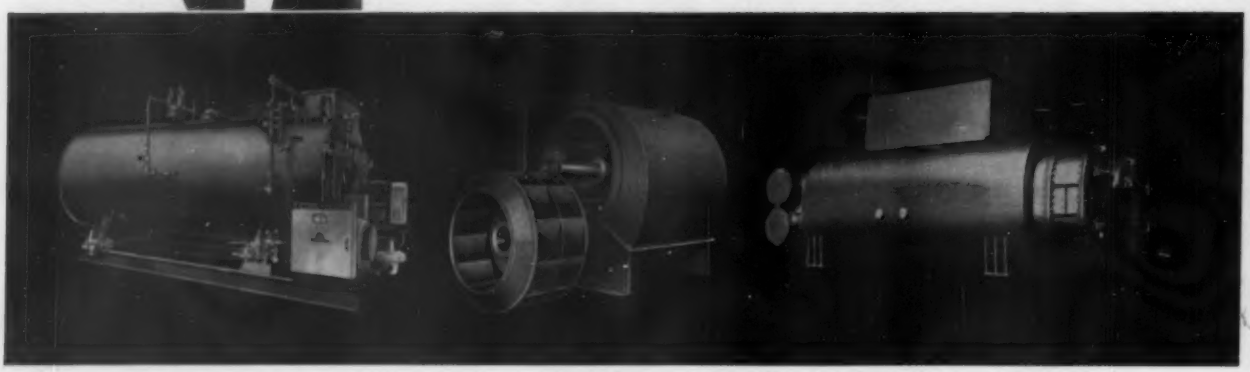


20" Yarway Type W Gun-Pakt single-end joint with welding ends, 8 guns.

YARWAY® GUN-PAKT

Calling in equipment to



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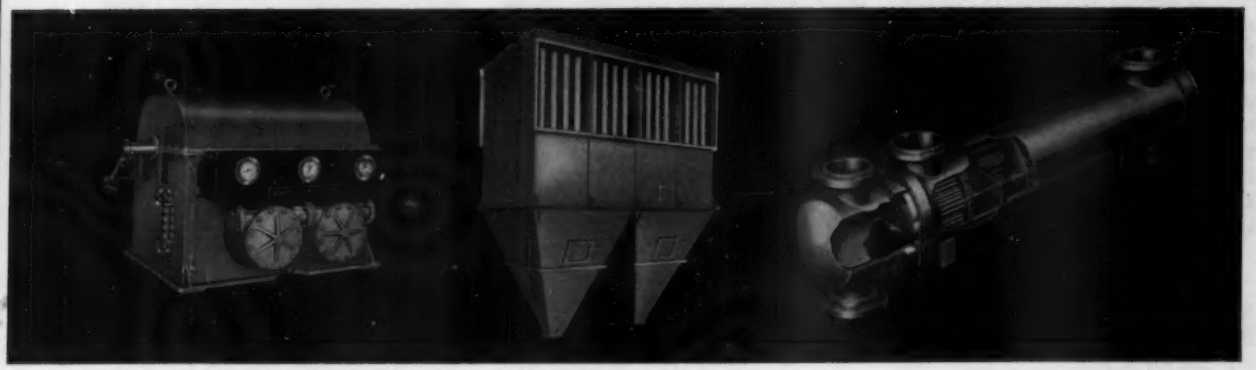

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Standard and engineered heat exchangers and feedwater heaters for every duty.

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HELPFUL WATER CONDITIONING DATA FROM BETZ

SOLVING AN UNUSUAL CASE

■ Internal baffling must be in good condition for production of pure steam.

A LARGE paper plant had operated for many years utilizing steam generated by six 2 drum longitudinal, straight tube boilers. In 1947, one of these units was removed and a new 100,000 lb. per hour boiler, designated as Boiler No. 1, was installed.

During the latter part of 1955, 8 years after installation of the boiler, evidences of carryover of boiler water with the steam began to develop. Regulating valves operated erratically and stop valves failed to close completely or became inoperative. Examination revealed the accumulation of large quantities of sludge obviously deposited as a result of boiler water carryover. With the first indication of carryover, investigations of various factors which might contribute to this problem were conducted. Raw water and feedwater characteristics were checked and the boiler water treatment as well as chemical balances maintained in the boilers were reviewed. Periodic checks of steam purity indicated that a satisfactory degree of steam purity was being produced by the older boilers. However, Boiler No. 1, the newer boiler, indicated a high degree of carryover during these preliminary checks, with a solids content of the steam as high as 20 ppm.

Mechanical Factors

Since preliminary tests had indicated that Boiler No. 1 was the offender in the carryover problem, a study was started on this unit. Figure 1 indicates the measured steam purity at the start of this study on Boiler No. 1. For the purposes of contrast, a short section of this chart (3 o'clock position) is devoted to Boiler No. 2.

Figure 2 indicates steaming rates of Boiler No. 1 during this period.

An analysis of a boiler water sample indicated a dissolved solids content approximating 1,400 ppm with normal concentrations of alkalinity and phosphate present.

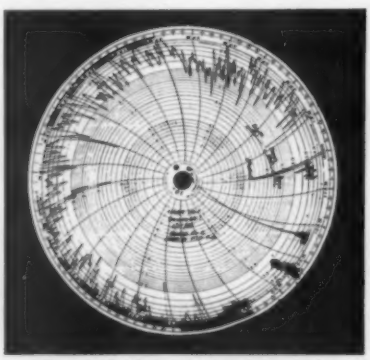

Figure 1—Record of steam purity, Boiler No. 1

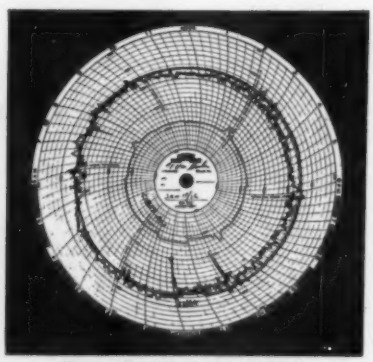

Figure 2—Steaming rates of Boiler No. 1

On the following day a sample of the condensed steam indicated a conductivity of 60 micromhos. Then, the water level was lowered until it was maintained at approximately two inches from the bottom of the glass. No change in conductivity was noted. After returning the water level to normal, the steaming rate on the unit was then decreased to 40,000 lb. per hour. The conductivity of the steam promptly decreased to 5.5 micromhos. In re-establishing the load on the boiler, certain fluctuations occurred in steam ratings which were promptly reflected in the conductivity recording. Typical variations in steam purity, coinciding with load variations, continued to be apparent after this portion of the test was concluded. At the time of these tests, the boiler water solids concentration varied between 1,500 and 2,000 ppm.

Chemical Factors

A comparison of steam conductivity values at the start of the test on Boiler No. 1 with those values obtained after solids concentrations were lowered to 1,000 ppm and held there consistently, indicated a reduction in contamination which was roughly proportional to the solids content of the boiler water as well as the load rating.

A suitable concentration of a specially-selected anti-foam agent was injected into Boiler No. 1 on the following morning, and thereafter added continuously in order to maintain the desired concentration of anti-foam in the boiler water. Subsequent results did not show any distinct improvement as a result of the addition of the anti-foam although some reduction in conductivity was obtained, approximating 5 to 10 micromhos.

Under ordinary circumstances, where carryover of boiler water with the steam is being caused by foaming or priming due to high suspended solids, high dissolved solids, high alkalinity or other similar chemical factors, the use of these special anti-foam agents would definitely have caused a considerable reduction in conductivity of the steam. The fact that no outstanding improvement in steam purity resulted after this treatment indicated that the basic cause of carryover was not chemical in nature.

Summary

The study up to this point had brought out the following facts:

There was no evidence of foaming or other carryover of boiler water with the steam caused by chemical factors at this time. The older boilers received the same feedwater and treatment and maintained the same chemical balances and solids concentrations in the boiler water as Boiler No. 1, indicating that a steam of satisfactory characteristics was produced at all times.

The application of a proper anti-foam had no appreciable effect upon the steam purity. A pronounced effect would have been encountered if carryover had been due to chemical causes induced by high suspended solids, high alkalinity or high dissolved solids.

Reduction of water level had no bearing on the steam purity. Conversely, the

baffling in the boiler normally should permit a considerable variation in water level with the production of pure steam.

A reduction in the boiler rating caused a direct and definitely quantitative reduction in solids content of the steam. This effect was so remarkably consistent that for any set of conditions, the boiler rating could be estimated rather accurately from an inspection of the steam conductivity chart.

A reduction of the solids content of the boiler water from 2,000 ppm dissolved solids to 1,000 ppm dissolved solids caused a distinct reduction in the solids content of the steam approximating half of the original values.

The nearly quantitative variations in steam conductivity corresponding to variations in steam rating and boiler water dissolved solids concentrations indicated that the difficulty with Boiler No. 1 was being caused by leakage of moisture past the internal baffles and screens.

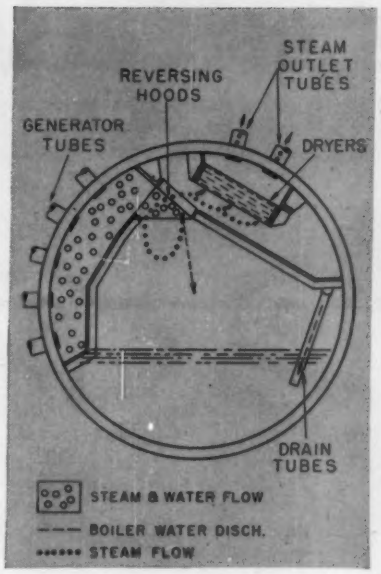

Figure 3—Cross-sectional detail, with drying arrangements in boiler drum.

be cleaned with inhibited acid. Also, with the reassembly of the baffling, the separation noted in the steam dryer bank would be corrected.

Two weeks after the study was completed, the boiler was thoroughly acid cleaned and the internals rebuilt. When the boiler was placed on line, frequent spot checks indicated an uncorrected conductivity of 4 and 5 micromhos for the steam at 90,000 lb. per hour rating and boiler water dissolved solids concentrations between 1,500 and 2,000 ppm. The uncorrected value of 4-5 micromhos is equivalent to a corrected conductivity of approximately 1.0 micromhos, equal to 0.5 ppm dissolved solids in the steam. The present value of 0.5 ppm solids contrasts considerably with the values of 30 ppm and higher at the beginning of the study.

On the basis of the results obtained, it is obvious that the regasketing and acid-wash operations were carried out with complete success.

OF CARRYOVER

Boiler Inspection

Boiler No. 1 was inspected for the primary purpose of determining whether or not any disarrangement of the steam separating internals might be the cause of the carryover condition. Figure 3 illustrates the cross-section details of the baffling installed in Boiler No. 1.

Several slight cracks were found in a small number of the reversing hoods and four openings (varying in diameter from ¼″ to ½″)—resulting from a poor fit between the end plates of the steam baffling and the protective shields around the safety valve nozzles. It was also noted that the gasketing inserted in the bolted joint between the end plates and the rigid supports attached to the drum itself was in very poor condition. One section gave distinct evidence, by the deposition of boiler water solids, that some boiler water had by-passed the steam baffling.

Removal of certain portions of the baffling permitted an inspection of the entire bank of dryers. In approximately the center of the boiler, a separation in the shape of an elongated triangle, approximately 2″ wide at the base, was found to exist in the center of the steam dryer bank.

Close attention was given, during the inspection, to the possibility of any sludge accumulations in the baffling, reversing hoods or in the drain lines from the dryers which might possibly interfere with the efficiency of such equipment and thus cause the carryover condition. No such accumulations were noted at any point which might possibly have contributed to the problem.

Recommendations

Production schedules did not permit dismantling of the separator for complete repairs. Correction of the apparent leaks were made initially and the boiler was returned to service. A recheck of the steam purity indicated substantial improvement, but complete correction of the problem did not result from the partial repairs. It was apparent on the basis of these tests that further corrective measures were necessary. It was felt that these measures should include a complete dismantling of the internal baffling and reassembling, using new gasket material. In order to obtain the maximum benefit from the regasketing, and to provide the boiler with the first complete cleaning in 8 years of operation, it was recommended that the boiler

Conclusions

The experiences of this study are not to be considered as a reflection upon the equipment manufacturer. Rather, they point up the necessity of periodic checks on steam purity as a basic requirement of good operating practices.

A *complete* water service program should include close checks on steam purity by an organization with wide experience in the solution of such problems.

The case of carryover discussed here is only one of many unusual problems solved by BETZ LABORATORIES. If you have an unusual industrial water problem—*any* problem, large or small—why not call in a Betz Field Engineer for a helpful discussion? A good time to do it is *now!*

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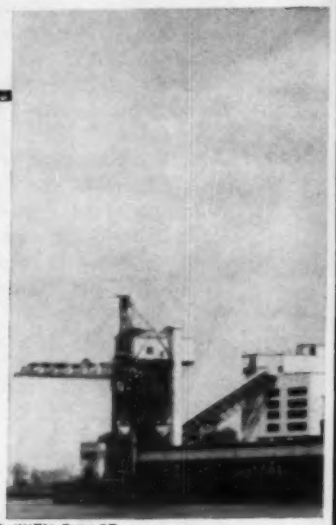

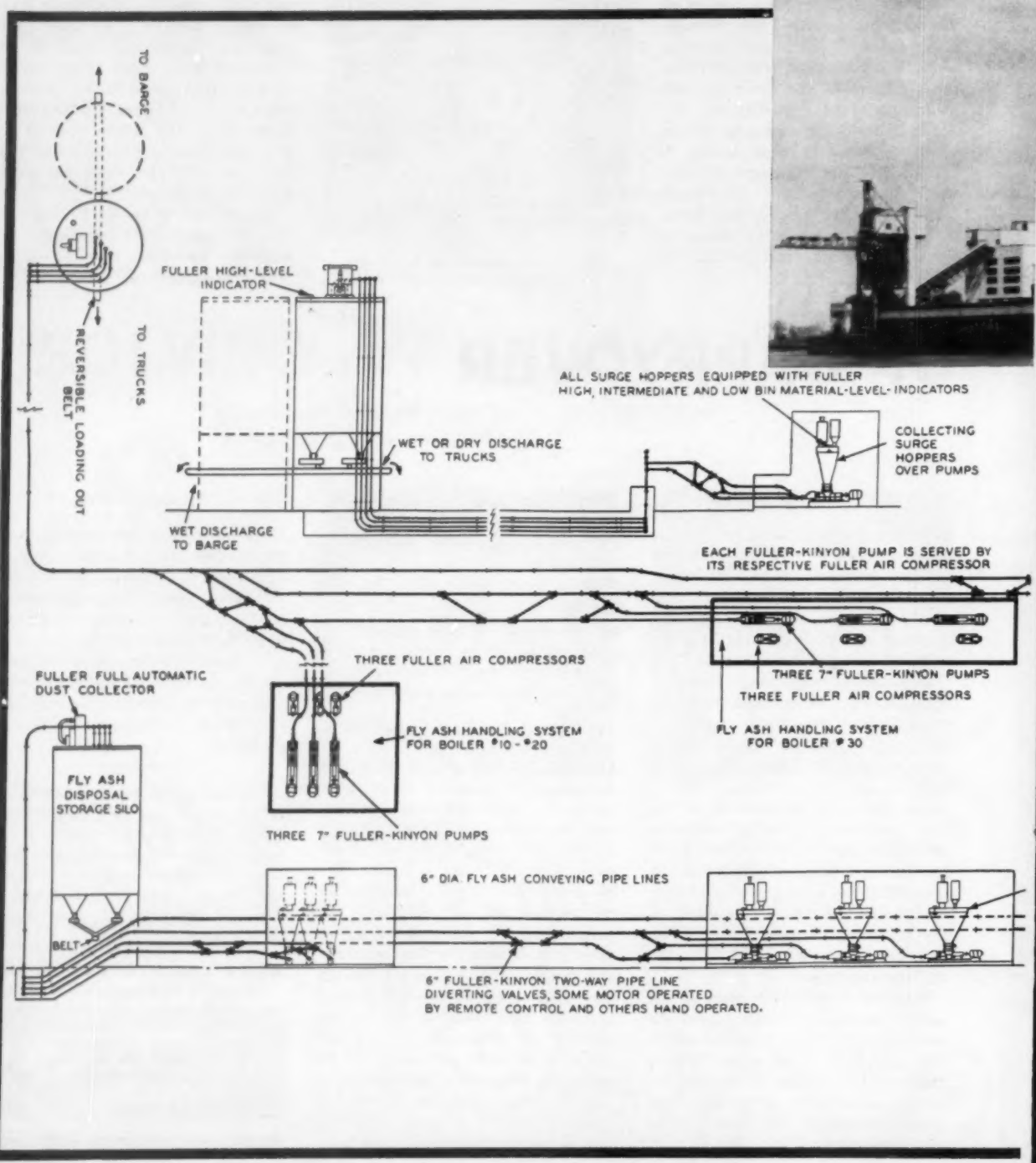
TO BARGE
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FULLER HIGH-LEVEL INDICATOR
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THREE 7" FULLER-KINYON PUMPS
THREE FULLER AIR COMPRESSORS
FLY ASH HANDLING SYSTEM FOR BOILER #30
THREE FULLER AIR COMPRESSORS
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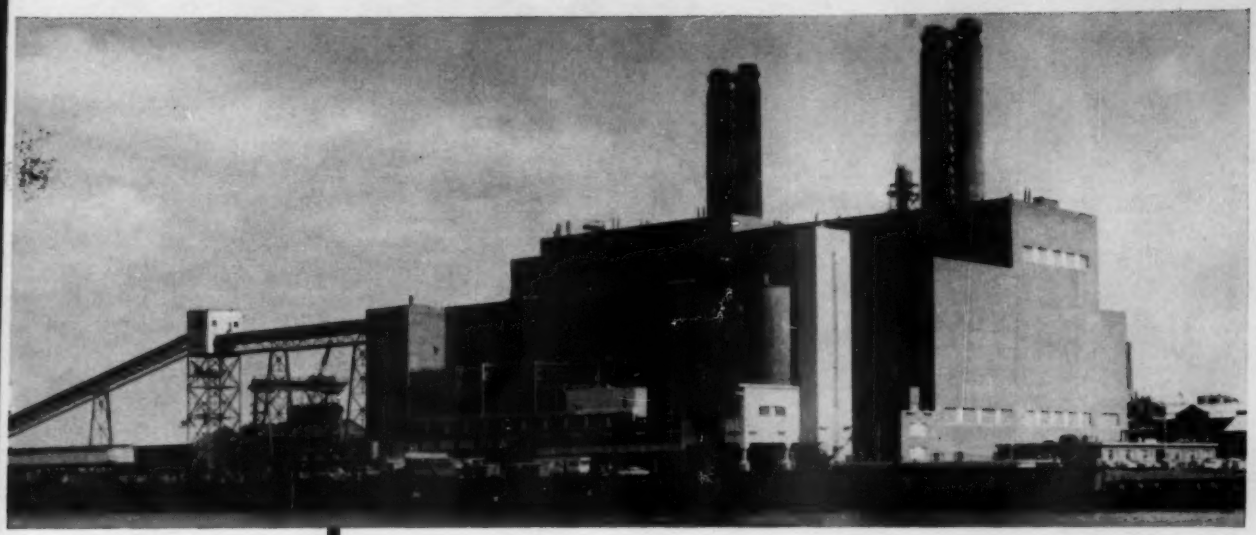
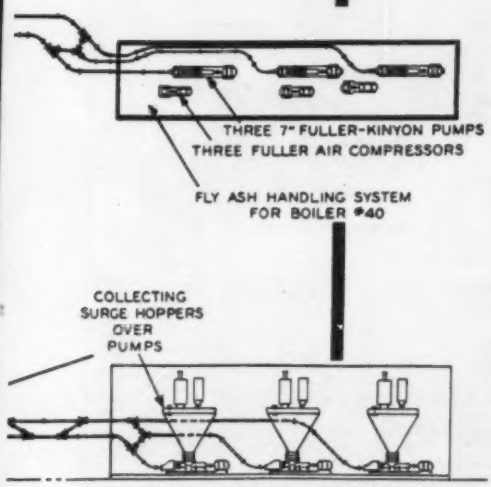
FLY ASH DISPOSAL STORAGE SILO
BELT
THREE 7" FULLER-KINYON PUMPS
6" DIA. FLY ASH CONVEYING PIPE LINES
6" FULLER-KINYON TWO-WAY PIPE LINE DIVERTING VALVES, SOME MOTOR OPERATED BY REMOTE CONTROL AND OTHERS HAND OPERATED.

FLY ASH HANDLING SYSTEMS CON EDISON'S ASTORIA STATION




THREE 7" FULLER-KINYON PUMPS
THREE FULLER AIR COMPRESSORS
FLY ASH HANDLING SYSTEM FOR BOILER #40
COLLECTING SURGE HOPPERS OVER PUMPS
ALL COLLECTING SURGE HOPPERS OVER FULLER-KINYON PUMPS ARE SERVED BY SEPARATE CONVEYING SYSTEMS DIRECT FROM PRECIPITATOR HOPPERS

The Astoria Station of Consolidated Edison, in New York City, is expanding to meet the increasing power needs of its industrial and residential community. Here three Fuller fly ash systems are now handling up to 35 tons of fly ash, per hour, per system. Consolidated Edison has specified another Fuller system for its forthcoming new boiler.

Fly ash collecting at Consolidated Edison has been effectively streamlined. Much of the ash is first removed from the gas stream by a mechanical precipitator. The remaining small particles of ash left in the gas stream are trapped by an electrostatic precipitator into other collecting hoppers. From the hoppers the ash is transferred by vacuum to a collecting transfer bin which discharges into the Fuller system. This ash is conveyed to a dock silo, where it is wet down and hauled away by trucks or barges. The entire operation is automatic, economical and highly efficient.

Handling of fly ash with Fuller systems offers significant advantages to the cost-conscious power plant operator. Industry surveys point to an increased use and value of fly ash in the near future.

Both large and small plants can gain the advantages of Fuller fly ash handling at low cost. Capacities range from 100 to 8000 cubic feet an hour. Why not take advantage of Fuller pneumatic conveying in your plant? Write today for complete information.

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Because of Astoria Station's physical layout, pipelines (through which the ash passes) go underground to base of storage silo and then ascend vertically to the top in an enclosed elevator shaft. Fuller-Kinyon conveying systems can be tailored in a similar manner to the requirements of any installation . . .

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The Edison Omniguard system keeps constant watch on critical temperatures throughout electric generating plants. Omniguard monitors such vital temperatures as those of bearings on the main turbine generator, fluid drives, coal pulverizers, main feed pumps and other vital auxiliaries.

When overheating occurs the alarm sounds *before* damage occurs and corrective action may be taken immediately.

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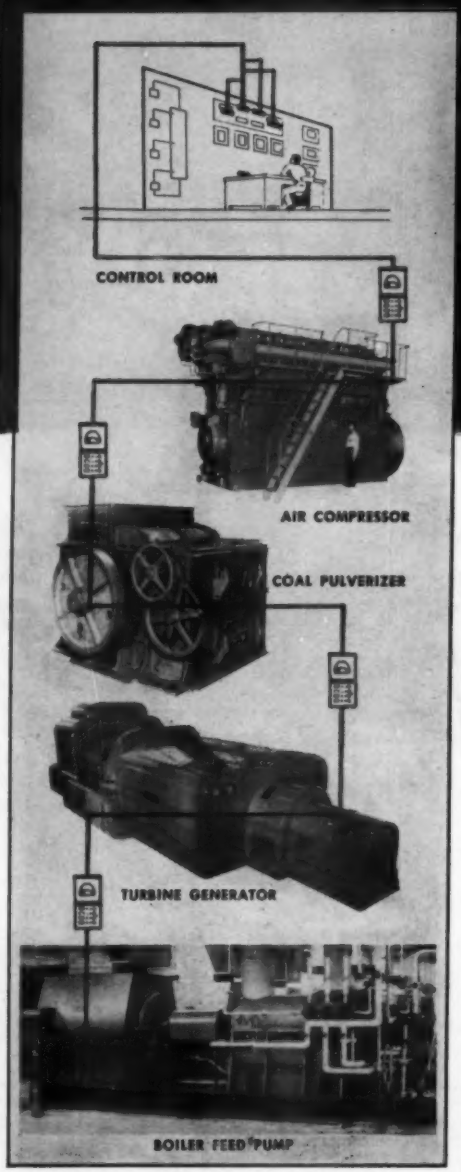
For additional information on Edison Model 310 Omniguard temperature monitor and the wide variety of detectors available for use on all types of auxiliaries, pressure vessels, tanks and pipe lines, write for publication 3036C.



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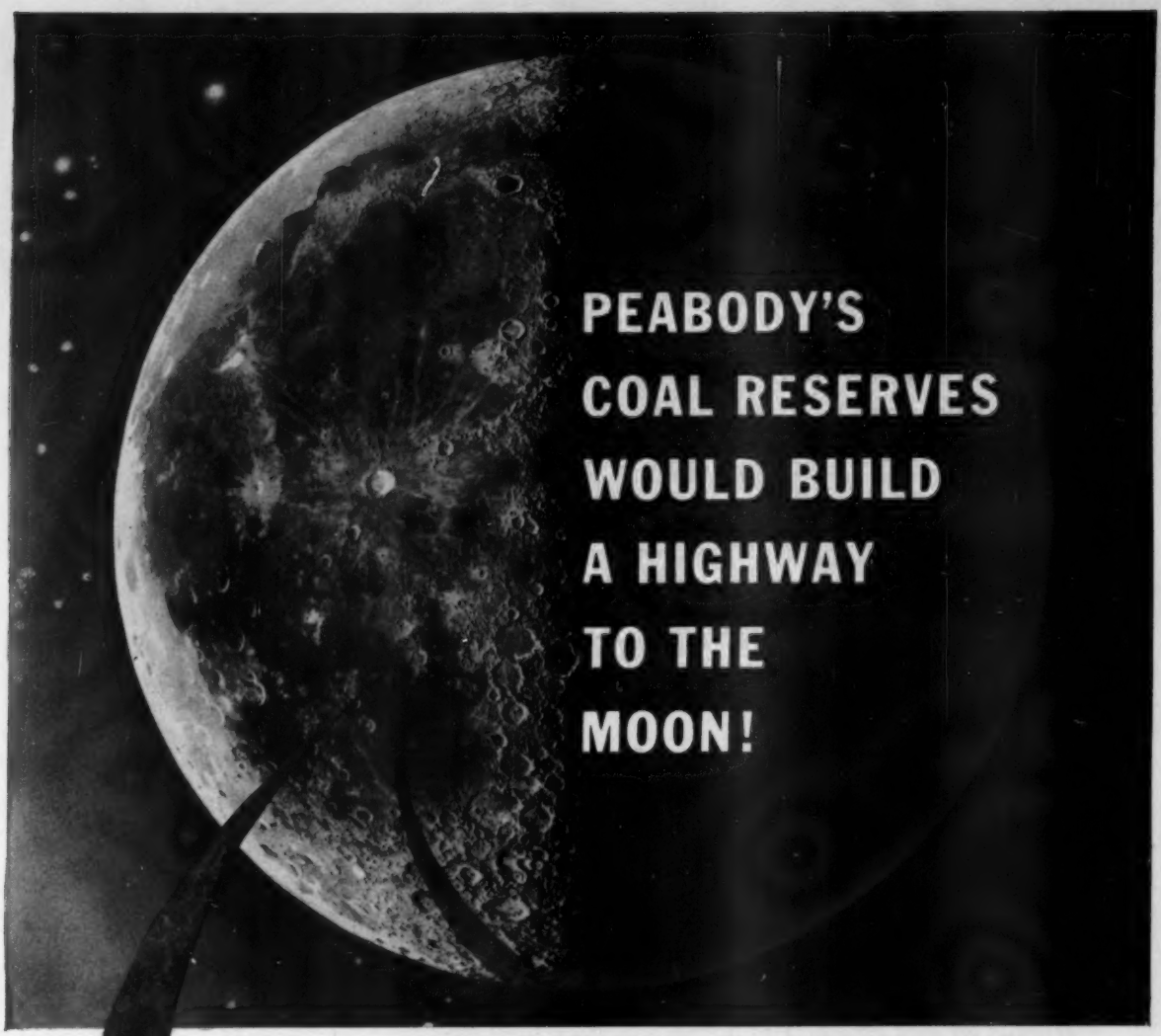

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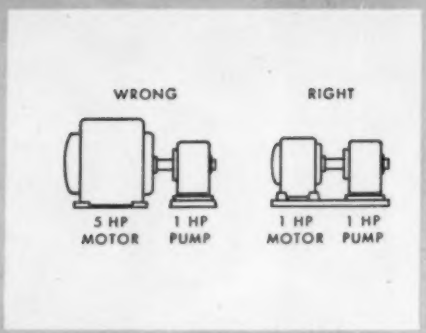
Tips on evaluating Electrical

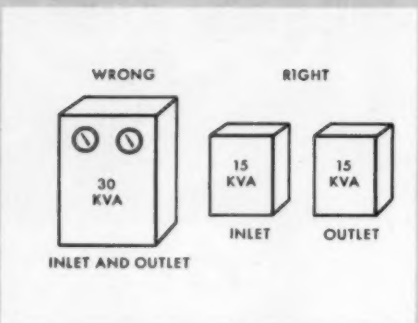
Matched Electrical Sets

You wouldn't use a 5 h.p. motor to run a pump that required only one h.p. Similarly, electrical sets should be *matched* to the requirements of the specific job. Electrical sets should be sized according to gas conditions, dust conditions, and other operating characteristics, and in accord with manufacturers' past experience on similar installations. *Don't be misled by high KVA ratings on the electrical sets.* The precipitator will only absorb a certain amount of power and the sets should be sized accordingly. A large excess of installed power, which will never be used, means inefficient use of the equipment.



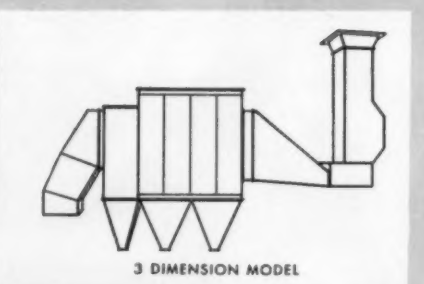
Varied Electrical Conditions

Electrical conditions in a precipitator can vary widely at different parts of the precipitator. For instance, a high voltage, low current condition usually prevails at the inlet where the dust load is high, as compared to a lower voltage higher current condition at the outlet. Consequently, it is good design (and a necessity for high efficiency) to furnish several electrical sections in series, with energization from separate electrical sets so that each section can be adjusted to best suit the conditions.



Gas Distribution

Remember that gas distribution, gas baffling, and provision against hopper sweeping all have a large influence on collection efficiency. The gas flow system should be analyzed as closely as possible, both in the precipitator and in the associated ductwork. If in doubt, have a three-dimensional gas flow study made. Two-dimensional gas flow studies *are not as accurate* and may lead to erroneous conclusions.



RESEARCH

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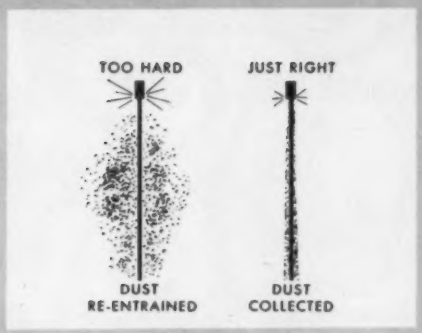
RS 101

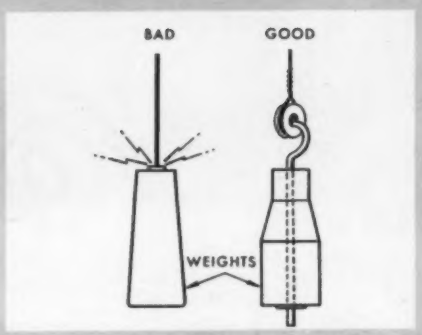
Precipitators

Some helpful hints to aid in selecting a properly designed unit



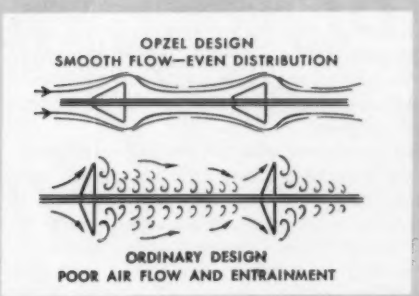
Rapping Intensity

Rappers should have easy means to vary the intensity of the blow to suit variations in operating conditions. A pre-set intensity setting cannot possibly give proper rapping over the normal range of operation. If too soft, build-up will occur which will disturb electrical conditions. If too hard, there will be reentrainment. Means of intensity adjustment are necessary to avoid drop-off of precipitator efficiency as conditions change.



Corona Discharge

It is a relatively easy matter to obtain a corona discharge in an electrostatic precipitator. Many types of discharge electrodes have been used over the past forty years, including ribbons, squares, twisted squares, star shaped sections, coiled wires, wires with prongs and projections, most of which give entirely adequate corona conditions. Final choice then gets down to mechanical factors such as strength of wire, method of support to avoid stress points, and ease of handling. There are many claims made for various types of wires but after investigating and testing hundreds of different kinds, we find a straight round wire about .1" diameter to be best.



Baffle Design

Careful attention to the design of baffles on the collecting plates is most important. Small amounts of reentrainment mean tremendous differences in over-all collection efficiencies. It is seen that the "quality" of the collecting surface is far more important than quantity — quantity (sq. ft. of surface or treatment time) in itself is not a criterion of performance.

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1. *Simplicity* – only one moving part.

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4. *Uniform performance* – operates equally well on heavy, light, or no condensate load.

5. Operates against *back pressures* up to 50% of inlet pressure. 6. *Rugged* – unaffected by superheat, water hammer, vibration, or corrosive condensate. 7. *Minimizes inventory* of spare parts.

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at start-up. Immediately rids lines of condensate and air to permit normal operation. This eliminates the need for manual opening of valves to drain the system.

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In these days of sharp emphasis on cost control, Sarco Thermo-Dynamic TD Traps are helping plants to deliver the full productive power of every pound of steam. And because the TD has no mechanism . . . no gaskets . . . no narrow channels to clog, maintenance cost on the TD is almost nil. As one plant engineer puts it: "This TD is a cinch to install, it's no bigger than a tee fitting, and it works in any position. The TD is the one steam trap we can install and forget."

CHOOSE THE RIGHT TRAP

There's an infinite variety of applications, temperatures, pressures and loads in industrial steam piping. Sarco can help you select the right trap for every job of air and condensate removal, saving you money and down-time.

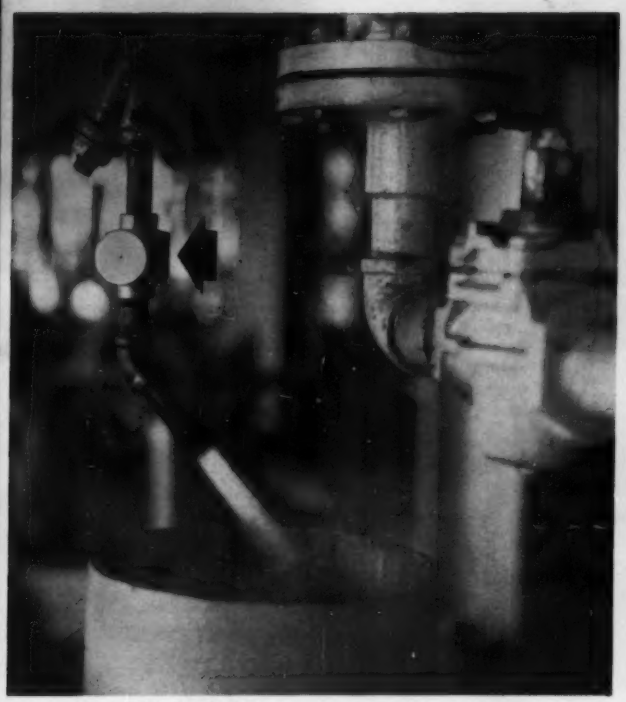
HOW ABOUT THE BUCKET TRAP?

With the development of the patented* Sarco Thermo-Dynamic Steam Trap, the bucket trap suddenly aged 50 years. In a nostalgic way we feel somewhat sorry, because *our* Sarco bucket trap has made us thousands of friends. But frankly, it's no match for the new Sarco TD. Progress is progress.

Some of our customers who are getting satisfactory service from our bucket traps may prefer to replace their old Sarco bucket traps with *new* Sarco bucket traps. If you feel this way, we're flattered enough to keep on making Sarco Bucket Traps – strong, sturdy and durable as ever. Let us suggest, however, that you at least give the new Sarco Thermo-Dynamic Steam Trap a try, under your most exacting conditions.

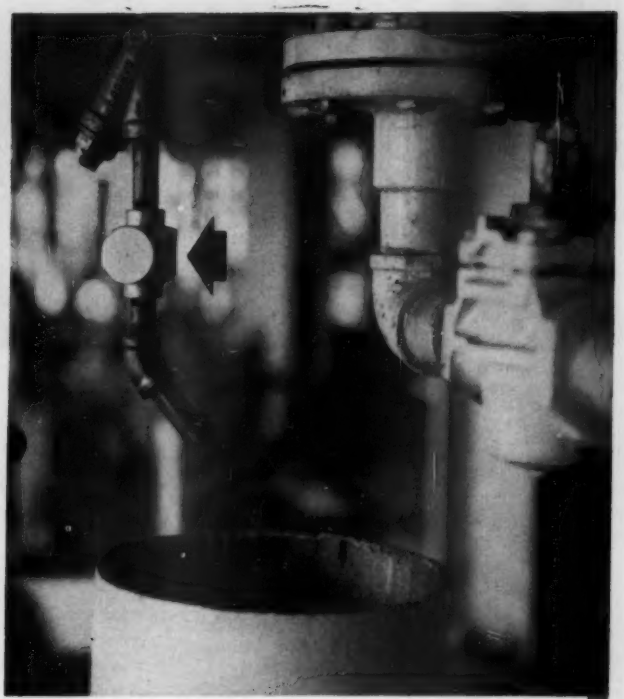
*U.S. Pat. No. 2,817,353 T. M. Reg. U. S. Pat. Off.

that does what a steam trap should



2. DISCHARGES

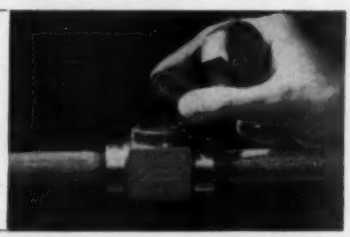
air and condensate at steam temperature as rapidly as they collect. Does not wait for a bucket of steam to leak through a small orifice.



3. CLOSES TIGHTLY

There is no continuous bleed; nor is there loss of buckets of steam as in the bucket trap which must discharge steam with each cycle.

MAINTENANCE TIME: 40 SECONDS!



How long does it take your maintenance crew to service an ordinary trap? If it's over a couple of minutes, you're throwing away valuable time. The Sarco TD can be cleaned, blown out, if necessary, and reassembled on the line, in as little as 40 seconds. 6345-B

Sarco can give you impartial advice on trap selection because Sarco makes All–5 Types:
Thermo-Dynamic . . . Thermostatic . . . Liquid Expansion . . . Float Thermostatic . . . Camlift Bucket

SARCO COMPANY, INC. 635 Madison Avenue, New York 22, N. Y.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

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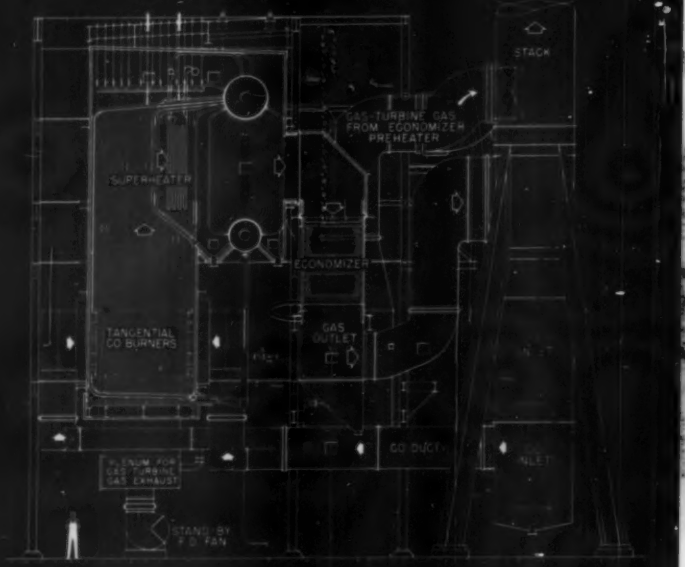
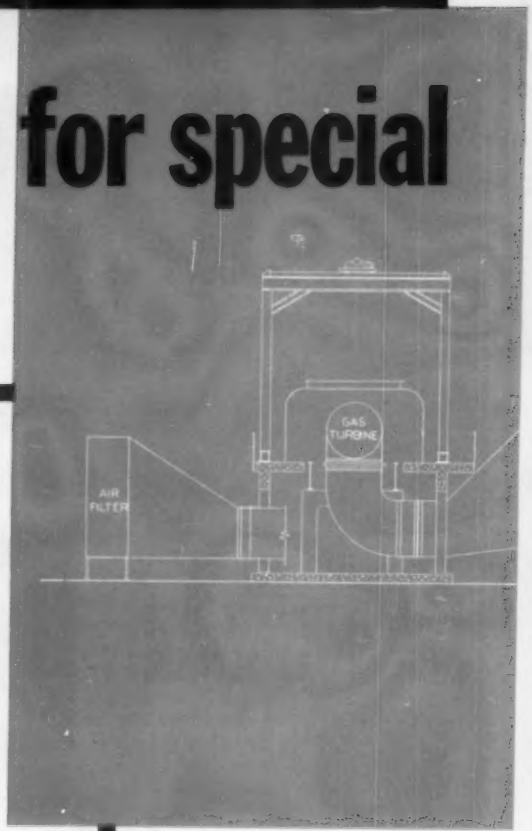
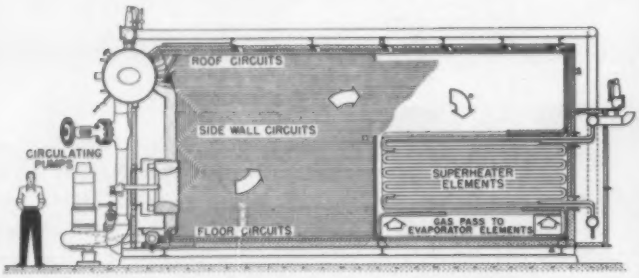


For refineries

C-E Vertical Unit Boiler, Type VU-40 CO – tangentially fired boilers to efficiently utilize energy potential in hard-to-burn waste catalyst regenerator gas. Illustrated is an installation at a Gulf Coast refinery. It combines a catalyst regenerator, two gas turbine-driven compressors, two CO boilers, and separate turbine-exhaust-gas feedwater heaters located between the boilers. Available in a wide range of sizes for any quantity of catalyst regenerator gas and for any steam capacity, CO Boilers by C-E have been in service more than three years.

Special boilers for special





For diverse industrials

C-E Package Boiler, Type PCC—new, completely shop-assembled, high performance, Controlled Circulation steam generator. Now in service with capacities to 120,000 lb/hr, it is available with temperatures to 900 F. and pressures to 1,000 psi (or higher if desired). This boiler is especially suitable where maximum capacity, temperature, and pressure are required, yet space is limited. Offers easy handling of rapid load swings and high quality steam production. PCC's in service include the world's highest capacity, highest pressure, and highest temperature package boilers.

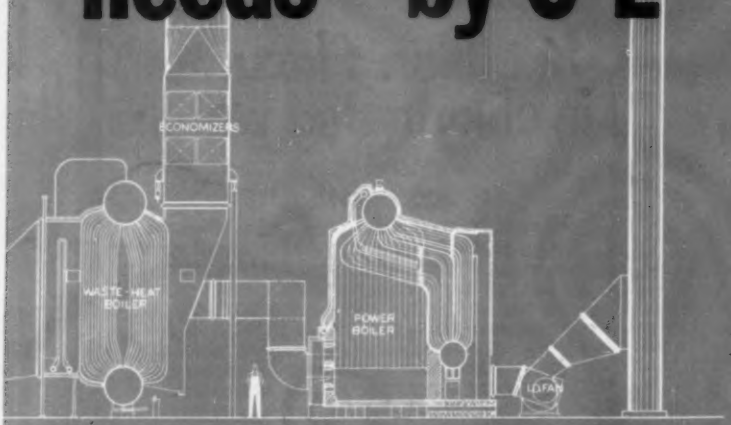
C-E builds boilers of virtually all designs and types known in present practice . . . in capacities from less than 10,000 to 4,000,000 or more lb. of steam per hr. It is presently building units that will set new world records for capacity, pressure and temperature.

This vast experience has also been successfully applied to the development of many special designs to utilize waste fuels or to meet unusual steam requirements or space conditions.

A few recent examples of special C-E designs which have successfully met unusual problems are illustrated here. In several cases, this success may be attributed to the utilization of exclusive C-E developments such as controlled circulation or tangential firing.

Whether your requirements call for boilers of unusual characteristics, such as those shown here, or for more conventional standard designs, come to C-E where you'll find the skill, experience, facilities—and desire—to meet your needs *exactly*.

needs – by C-E

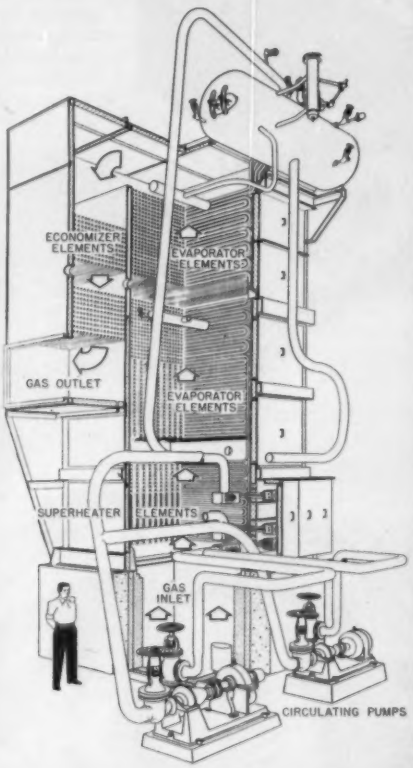


For gas turbine installations

C-E Gas Turbine Boiler—waste heat design for economical utilization of gas turbine exhaust sensible heat. Usable in a choice of cycles to obtain fired or unfired heat recovery and steam generation. Illustrated is a combined cycle, two of which are in service at a chemical plant. Here the turbine is followed by a waste heat boiler, multiple-purpose economizers (process and feedwater), and a conventional oil-fired steam generator which uses a portion of the high temperature exhaust gas for combustion air.

For the steel and chemical industries

C-E Package Boiler, Type WCC—a Controlled Circulation design which utilizes waste heat from open hearths or chemical processes. The platen surfaces featured in the first pass permit passage of abrasive or "sticky" gas without erosion or bridging, prolonging boiler life and making the unit easier to clean. Controlled Circulation assures positive control of water to all circuits, permitting a smaller boiler with obvious space-saving advantages. Seven WCC's are now in service; eight others are being erected.



COMBUSTION ENGINEERING

Combustion Engineering Building, 200 Madison Avenue, New York 16, N. Y.

C-195

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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POWER POINTERS

257,500,000,000,000 BTUs

SINCE INSTALLING ONE OF THE COUNTRY'S FIRST HIGH PRESSURE FEEDWATER HEATER SYSTEMS, AN EASTERN POWER PLANT HAS CONVERTED OVER 10¼ MILLION TONS OF COAL INTO BTU'S. YET NOT A SINGLE MONEL TUBE IN ANY OF THE HEATERS HAS BEEN REPLACED. HEATERS OPERATE AT 2000 PSI WATER PRESSURE, USE STEAM AT 900° F. STRONG MONEL* NICKEL-COPPER ALLOY RESISTS CORROSION, PERMITS USE OF RELATIVELY THIN-WALLED TUBING FOR MAXIMUM HEAT EXCHANGE.

¼ billion flexures in chlorinated water

...Monel check valve springs still springy

IN 1932, 3450 MONEL CHECK VALVE SPRINGS WERE INSTALLED IN A METROPOLITAN WATER PLANT'S FOUR LARGE PUMPS. PREVIOUSLY, STRESS-CORROSION BECAUSE OF CHLORINE IN THE WATER CAUSED CRACKING AND FAILURE OF SPRINGS, SHORTENED THEIR LIFE TO 3 YEARS OR LESS. TODAY, OVER 90% OF THE ORIGINAL MONEL SPRINGS ARE STILL IN SERVICE, MANY AFTER 25 YEARS AND OVER A QUARTER BILLION FLEXURES.

The metal that comes back from Davy Jones' locker

MONEL ALLOY TAGS CLIPPED TO PUPS' FLIPPERS COME BACK FROM THE DEEP TO TELL A TALE OF THE MIGRATIONS OF SEAL HERDS. THE U.S. FISH AND WILDLIFE SERVICE FINDS MONEL ALLOY RETAINS IDENTIFYING MARKS FOR AS LONG AS 12 YEARS DESPITE SALT-WATER CORROSION AND ABRASION FROM ROCKS AND SAND.

Slowed down by a metal problem?

A TALK WITH ENGINEERS FROM INCO'S MECHANICAL ENGINEERING SECTION MAY HELP YOU GET BACK ON SCHEDULE. JUST GET IN TOUCH WITH US AND OUTLINE THE DETAILS. AND FOR A USEFUL RUN-DOWN ON MONEL ALLOY, WRITE DEPARTMENT **PE** FOR 30-PAGE INCO BULLETIN, "ENGINEERING PROPERTIES OF MONEL AND 'R' MONEL ALLOYS".

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO

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INCO NICKEL ALLOYS

For more data circle 514 on Post Card

HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 129 and 130.

ELECTRICAL

101 Master Unit Substations — Publication GEA-3800D, 58 pp, describes use of company's master unit substations in handling protective, transformation and switching problems in industrial and utility power distribution systems. Subjects discussed include system reliability, substation flexibility, engineering, unified billing and responsibility, space requirements, appearance, installation, maintenance, ordering, ratings and dimensions. Includes photos, drawings of network arrangements. General Electric Co.

102 Distribution Equipment — Bulletin SB-555 contains 34 pp of detailed information on company's line of switchboards and secondary unit substations for a variety of distribution requirements. Illustrates and describes construction features and includes detailed application data, ratings, dimensional mounting data, schematic diagrams and dimensional drawings. Bulldog Electric Products Div., I-T-E Circuit Breaker Co.

103 Motor Control Center — Design and operation advantages of company's motor control center are detailed in this illustrated product booklet. Photos of component features are included, as well as suggested specifications and other data. Electric Distribution Products, Inc.

104 Circuit Breakers — Specifications and construction details on company's circuit breakers are provided in this 8-pp illustrated bulletin. Simplified for easy selection, bulletin presents high rupture capacity breakers, miniature size breakers and commercial type units. Wood Electric Co.

105 Safety Switches — Design and operation information on company's safety switches with Clampmatic action is presented in 16-pp Bulletin SS-260. Gives horsepower ratings, short circuit ratings, dimensional and knock-out data, and other data, and includes dimensional diagrams. Bulldog Electric Products Co., Div. I-T-E Circuit Breaker Co.

106 Switch Devices — Twenty-pp Catalog 67 describes a series of lighted indicator and pushbutton switch devices designed for combined indication and control. Split pages allow quick selection and comparison of operator units, indicator units, and switch units. Dimensional drawings and photos are included, as well as detailed engineering data. Micro Switch, Div. Minneapolis-Honeywell Regulator Co.

107 Lighting Duct — Comprehensive information on flexible and versatile lighting duct designed to meet a variety of lighting needs is presented in 38-pp Bulletin ULD-660. Illustrates and describes various types of lighting duct, suspension equipment, auxiliary equipment, methods of suspension, installation and use of essential fittings. Includes section on lighting system planning, giving recommended levels of illumination, lamp amperages, voltage drop and temperature rise, typical industrial layout. Bulldog Electric Products Div., I-T-E Circuit Breaker Co.

108 Portable Cord, Cable — Featured in 20-pp Bulletin PC-58 is a line of portable cords and cable for light, medium and heavy duty applications. Includes information of type of jacket, type of construction and type of conductor. Detailed selection tables on the various types of cord and cable available are included. Whitney Blake Co.

109 Silicon Rectifier — This data sheet gives descriptions, data and specifications on company's silicon power rectifiers. Complete information on electrical and mechanical characteristics and data on performance for diodes with capacities of 6, 20 and 40 amp per cell and with peak inverse ratings of from 50 to 500 volts is included. Syntron Co.

110 Selenium Photocell — Eight-pp Bulletin PC-649A describes selenium photovoltaic cells. Covers cell structure and operation, performance characteristics, output current curves and typical applications in electrical and industrial engineering, and many other fields. International Rectifier Corp.

111 Button Cell Battery — This illustrated brochure highlights features, design potentials and specifications of a line of nickel cadmium, button cell batteries. Typical applications are illustrated and tables of specifications included. Alkaline Battery Div., Gulton Industries, Inc.

MECHANICAL POWER TRANSMISSION

112 Helical Gear-Motors — Sixteen-pp Bulletin GEA-6704, illustrated in full color, presents construction features and applications of helical gear-motors and speed reducers. Cutaway drawings show maintenance features. Also provided is information on field and factory testing help. General Electric Co.

113 Variable Speed Belt — This 12-pp bulletin contains an alphabetical listing by make and model of variable speed units, and an interchange guide with other makes of belts. Conversion table and numerical listing, and list prices are also included. Browning Mfg. Co.

114 Variable-Speed Drives — Bulletin G-5812, 8 pp describes drives for infinitely adjustable output speeds from a constant rpm motor source operating from standard in-plant a-c circuits. Gives construction features, condensed drive specifications, available speed variations and accessories for company's Vari-Speed Motordrive, motor pulley and variable-speed transmission. Reeves Pulley Co., Div., Reliance Electric and Engineering Co.

115 V-Belt Drive — "The Modern Way To Design V-Belt Drives," 32 pp, provides drive design information on company's Super HC V-Belt drives. Drive tables, featuring a complete range of sheave diameters and belt lengths, show how to handle stock and non-stock drives. Includes section on analyzing the service level of the drive as well as specifications. The Gates Rubber Co.

INSULATION

116 Butyl Rubber Insulation — Physical, chemical and electrical properties of butyl rubber and applications in insulating and jacketing wire and cable are detailed in this illustrated 12-pp bulletin. Advantages of this type of insulation are fully detailed and typical applications listed. Thiokol Chemical Corp.

117 Internal Pipe Insulation — A technique for reducing installation cost of lines and vessels carrying hot gases under pressure is detailed in this 6-pp bulletin. Shows how Insidline, an internal insulation technique, separates effects of temperature pressure, making it possible for normal wall thicknesses of carbon steel piping to carry gases up to 2000 F. Bulletin discusses conditions under which Insidline is economically advantageous for pipe insulation. Baldwin-Hill Co.

VALVES, PIPING, FITTINGS

118 Cast Steel Valves — Twenty-pp Catalog KS1-M covers company's cast steel valves, including gate valves, globe valves, angle valves, and swing check valves for refinery and industrial applications. Describes construction features and operation and includes dimensions, pressure-temperature rating tables, and photos and diagrams. Kerotest Mfg. Co.

119 Surge Relief Valve — A surge relief valve for protecting water lines against overpressure in the system is described in 8-pp Bulletin W-2-A. The bulletin gives complete engineering information, detailed drawings and suggested specifications. Golden Anderson Valve Specialty Co.

120 Servo Valves — Catalog 150 describes operating principles, design features and performance characteristics of company's line of pressure control servovalves. Features a schematic diagram, detailed cutaway photo, and performance curves, as well as glossary of servovalve terms. Moog Valve Co. Inc.

121 Solenoid Control Valve — Bulletin 582-A describes a pilot operated, single and double solenoid control valve said to combine rugged construction, compact design, zero leakage and full ½ in. flow (257 cfm at 100 psig). Lists sizes and dimensions and includes cross section drawing showing components. Hunt Valve Co.

122 Air Control Valves — An informative discussion of air valves and their selection together with condensed catalog listings is featured in the 12-pp

Valve Finder. Provides an explanation of valve terms and principles. Includes three-step outline covering valve types, means of actuation and operating principles to simplify choice of valve. Includes pictures, descriptions, catalog data. Hannifin Co.

123 Monel, Nickel Valves — Bulletin 9 broadly defines applications of cast Monel and nickel valves to corrosive environment and describes their respective areas of usefulness. Gives chemical and mechanical properties and illustrates several basic valve designs. Alloy Steel Products Co., Inc.

124 Plastics in Piping — Handbook C-159, 16 pp, describes technology of plastic piping systems, installation and coupling methods, standards for plastic pipe. Provides temperature and working pressure chart for valves, and a table of service recommendations showing effects of 280 chemicals on five plastics used in manufacturer's valves. Gives data on ball valves, check valves, needle valves, fittings. Chemtrol.

125 Swivel Joints — Described in Bulletin DP 100 is a line of swivel joints for steam and hot gas service. Specifications and properties are listed, and dimensional data table and diagrams are included. Chiksan Co.

126 Forged Steel Unions — Eight-pp Bulletin U-2-58 provides detailed specification data on all types of forged steel unions, sizes, materials and pressure ratings. Design and application advantages are discussed and illustrated. Forge and Fittings Div., H. K. Porter Co., Inc.

127 High Pressure Fittings — Featured in this 18-pp bulletin are O-Seal fittings for use in any type of high-pressure piping system, containing water, oil or gas. Complete descriptive and engineering details on globe valves, check valves, nuts, tail pieces, threaded pieces, adapters, plugs, reducing inserts, and other fittings included. Combination Pump Valve Co.

BOILERS

128 Hot Water Boilers — Eight-pp Bulletin 1251 describes hot water boilers designed especially for forced circulation hot water systems for commercial and industrial space heating. Curves, tables, charts and photos amplify the text. Orr & Sembower, Inc.

129 Sizing of Boilers — Twelve-pp Fuel Engineering Data Booklet, Section C-A, describes recommended methods of sizing boilers and stokers for heating and process steam loads. Information includes five tables to simplify calculations and selection of boiler equipment. Bituminous Coal Institute.

COAL AND ASH HANDLING

130 On Coal Crushers — Five new bulletins describe reduction machinery for coal, other materials. Bulletins 937 and 939 cover single roll crushers and flextooth crushers respectively. Bulletin 938 deals with manufacturer's single roll Stokerkol sizer which employs a special segment for production of premium size stoker coals. Bulletin 940 covers the Flexroll coal crusher for reducing small capacities of coal to stoker sizes. Leaflet 949 describes a heavy duty slugger crusher for large size rock, mine refuse. The Jeffrey Mfg. Co.

131 Fly Ash Handling — Methods of handling fly ash using pneumatic conveyors are detailed in 16-pp Bulletin FF-49-1. Describes various pneumatic systems, control panels, feeders, rotary bin discharge valves, material level indicators, and pipeline diverting valves. Includes photos of typical installations, engineering and isometric drawings of handling equipment, and schematic diagrams. Fuller Co.

. . . Outstanding Among This Month's Catalogs

132 Considering an Analyzer? — Rental of manufacturer's giant analyzer for power-system studies on a time basis is covered in 8-pp Bulletin 3804-1A. Outlines basic principles of the analyzer, its operating advantages and types of studies it can perform, and gives information on the rental program. I-T-E Circuit Breaker Co.

133 Sprayed Coil Dehumidifiers — Bulletin 9427, 24 pp, describes draw-through and blow-through sprayed coil dehumidifiers for a variety of air conditioning applications. A section is devoted to principles of blow-through sprayed coil dehumidifiers. Also included are illustrations and descriptions of construction details, optional arrangements and related equipment. Typical specifications, a recommended procedure for sizing the unit and a discussion of three humidification methods provided in catalog. Industrial Div., American-Standard.

134 Soldering Aluminum — Detailed information on soldering aluminum is presented in this reference bulletin. Includes data on soldering fluxes, irons and flames, and gives information on soldering methods such as hot plate, dip, furnace, friction, glass fiber brush and ultrasonic operations. Types and properties of aluminum solders are explained, plus corrosion of soldering joints. Reynolds Metals Co.

135 Air Motors — Bulletin 76-B describes a line of heavy duty air motors designed for use where extremely high starting torque and sustained lugging of large loads is required. Complete specifications, dimension drawings, torque and horsepower curves, throttle variations and a cutaway illustration are included. Joy Mfg. Co.

METALS

136 High-Purity Tantalum — This technical folder describes application of high-purity tantalum to the electronic, nuclear, chemical and other industries. Describes forms in which the product is available. Detailed tables give exact chemical analysis and mechanical and physical properties. National Research Corp.

137 Aluminum for Heat Exchangers — Advantages of aluminum usage in heat-exchanger fabrication are described in this 16-pp bulletin. Covers aluminum heat transfer rates, temperature properties, tensile strengths, pressures and dimensional tolerances. Charts provide fingertip information on aluminum stress values, working pressures, thermal expansion and conductivity and friction factors. Reynolds Metals Co.

PUMPS, COMPRESSORS

138 Centrifugal Pumps — Single-stage centrifugal pumps featuring standardized construction, relatively few sizes, many interchangeable parts, are described in this 24-pp illustrated booklet. Provides selection charts, capacity data and dimensions for both close-coupled and base mounted models of the pumps. Taco Heaters, Inc.

139 Fire Pumps — Described in Bulletins 08B8551 and 08B9032 are fire and low pressure (booster) pumps — centrifugal double-suction, single-stage units for heads from 50 to 145 psi, capacities from 500 to 2500 gpm. Literature provides pump specifications, fire fitting arrangements, hose header locations, nozzle dimensions and selection chart. Allis-Chalmers Mfg. Co.

140 Dry Chemical Feeder — Volumetric extrusion type dry chemical feeders are described in 16-pp Bulletin 215. Discusses construction and operation of the feeders, and includes dimensional planographs, list of ranges of feeds, general technical data, graphs. Infilco Inc.

141 Oil-Free Compressors — Twelve-pp Bulletin A-44 provides data on 14 sizes of heavy duty industrial compressors from 95.6 to 939 cfm. Includes part-designated section drawings, installation photos and a section on the T-block design compression ring utilized in these vertical compressors. Joy Mfg. Co.

GRATING

142 Aluminum Grating — Featured in this 8-pp bulletin is aluminum grating for industrial installations. Safe load tables and dimensional data and diagrams included. Kerrigan Iron Works, Inc.

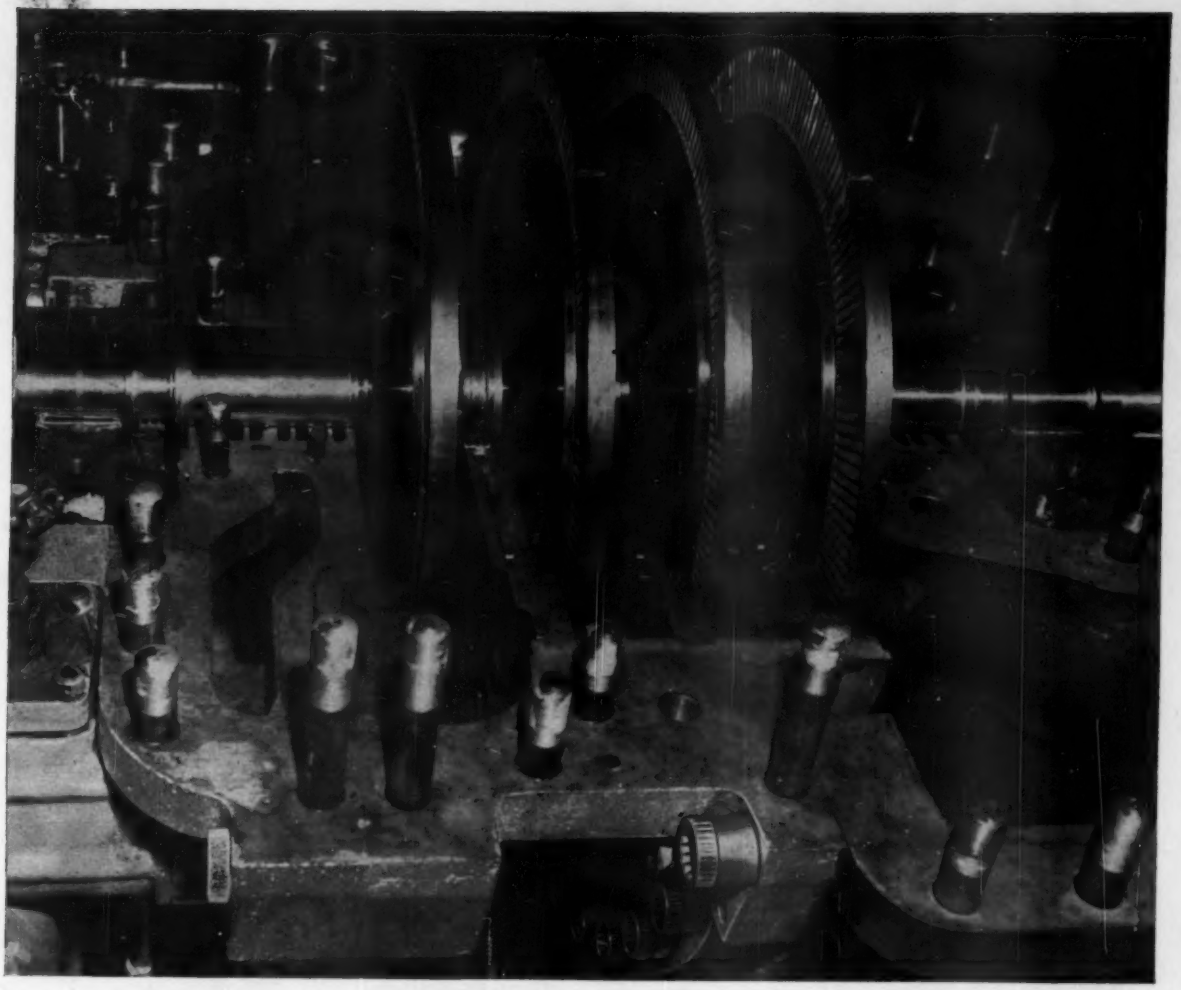
143 Safety Grating — Steel, aluminum and stainless steel safety grating for a variety of industrial applications is featured in 24-pp Catalog 5911. The illustrated catalog shows typical installations, and includes complete engineering data for erection, as well as detailed load charts and specifications. The Globe Co.

INSTRUMENTS, CONTROLS

144 Industrial Thermometers — Twelve-pp Catalog DT2-58 is filled with thermometer manufacturing and testing facts plus detailed thermometer descriptions and specifications. Explains reasons for hermetic sealing, external recalibration and double dampening. New thermometers shown include a 3-in. dial straight form, 4-in. dial (dished) and a 4-in. dial maximum hard set thermometer (also dished dial). Rochester Mfg. Co.

145 Magnetic Flowmeter — Six-pp Catalog 10D1416 gives information on an obstructionless magnetic flowmeter for metering difficult liquids such as concentrated acids and alkalies, slurries, paper pulp, waste sludges, sewage, pigment dyes, starch solutions, food products, black liquor and similar corrosive, abrasive liquids. Fischer & Porter Co.

146 Feed Regulator Level Control — Basics in the control of feeders which are operated by electric motors or electric



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR

DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA
Builders of Steam Power Equipment for Nearly a Century

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Here's **POWER**
to clean tubes from 1/2" to 2"
QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.

Air valve for one-man operation.

ROTOJET®
Junior **TUBE CLEANERS**

ELLIOTT COMPANY—ROTO PLANT
Tube Cleaner Specialists Since 1910
147 Sussex Avenue, Newark, N. J.

For more data circle 516 on Post Card

vibratory mechanisms, and the controlling equipment, are described in this 6-pp bulletin. Tells how the electronic feed controller works and how to install and start the control. Industrial Instruments, Inc.

147 Manometer Data — Featured in this 12-pp bulletin is a line of manometers, including well type, raised well type, sliding scale U-tube, absolute pressure, and U-tube types. Tables of design data and other engineering details are included. Trimount Instrument Co.

148 Combustion Control System — How combustion control systems are applied to four major makes of pulverized coal-fired boilers is illustrated and described in 12-pp Bulletin 510. Typical installations in power plants and process industries are listed. Bailey Meter Co.

149 For Zone Control — Air conditioning zone control cabinets are described and illustrated in 20-pp Bulletin AC-220. Separate sections with tables, curves and sketches cover proper unit selection, physical data, dimensions, fan performance and coil ratings for water cooling, direct expansion, hot water and steam. Buffalo Forge Co.

DUST CONTROL

150 Dust Control Unit — Featured in Bulletin V-100 is a conditioner unit for dust control, designed to apply rapid, on-the-spot conditioning to dust materials in all types of handling. Principles of operation are described in an accompanying engineering data bulletin, Bulletin V-101. The Johnson-March Corp.

151 Electronic Air Cleaner — Bulletin 258A, 16 pp, contains detailed information on electronic air cleaners which remove dust and smoke from the air by the use of the basic phenomena of electrostatic force. Explains electronic principle of operation, describes collector cell construction, gives details on design features. American Air Filter Co., Inc.

152 Packaged Dust Collector — Twenty-pp Bulletin 272-B, on company's Type B Roto-Clone, provides information on its application, design, construction, operation, installation and arrangements. Describes hoppers, precleaners, aftercleaners etc., including arrangements for trickle valve, dust doors, rotary locks and dust gates. Performance characteristics are charted, and capacities, shipping weights, air engineering data provided. American Air Filter Co., Inc.

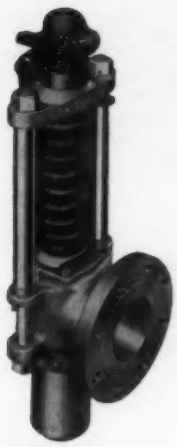
OTHER EQUIPMENT

153 Solving Corrosion Problems — This 24-pp booklet explains how company's duplex tubes help solve corrosion problems in condenser and heat exchange equipment. These bi-metal tubes are designed to provide maximum corrosion resistance in condensers and heat exchangers where two corrosive media are in process. Booklet gives data on heat transfer efficiencies, design and installation. Includes check list of applications indicating metal combinations which best resist attack from common corrosive media. Bridgeport Brass Co.

154 Instantaneous Heaters — Illustrated 24-pp Bulletin 304.4K1 presents instantaneous water heaters with extra-large steam inlet area. Seventeen pages of

STOPS VALVE LEAKAGE

at high pressures



Consolidated "Maxiflow" Safety Valve, Type 1700 Series, Sizes: 1½" thru 6".

The Thermodisc Seat in Consolidated "Maxiflow" Safety Valves solves the problem of valve leakage at high pressures, saves steam and reduces maintenance.

Research has shown that when a safety valve on high pressure service reseats after popping, a small amount of leakage occurs momentarily between seat and disc before the valve seals off and becomes tight. This leakage is comparable to steam flow through small, individual orifices.

When a small steam leak exists at some point on the valve seat, the area near the point is cooled by the refrigeration effect of the escaping vapor. The metal tends to contract causing slight deformation of the seat. This acts to increase the gap size between disc and seat bushing at the leakage point. The size of the gap increases rapidly until the rate of leakage becomes extremely high.

The Thermodisc Seat prevents seat distortion and consequent leakage with a seat element recessed to form a thin wall at the area of seat contact. This design permits a high rate of heat-transfer in the metal *that eliminates all thermal differences.*

The result is a degree of tightness, essential to the operation of safety valves in high pressure services, never previously achieved. For complete details, write for Bulletin 707B.

MANNING MAXWELL & MOORE INC. TRADE MARK

CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data circle 517 on Post Card

Workmen lining boiler furnace enclosure with Laclede Super Plastic.

Which of these advantages does your present boiler lining lack?

Laclede plastic and castable refractory linings, properly selected and installed, give long service life, greater efficiency, and permit more flexibility than other types of refractory linings.

Specific advantages for boiler constructions include

- High thermal shock resistance
- Long service life
- Minimum spalling
- Resistance to heavy loads, temperature variations, and the use of low-grade coal
- Especially suited to burner ports and flues
- Eliminate necessity for special tile around charging holes and access doors
- Air tight settings, even in furnaces of irregular shape

Use **Laclede** plastic refractories for front and bridge walls, burner ports, suspended arches, ignition arch construction, as a backing for water walls, and in other areas where high heat resistance is necessary. For complete details, contact your Laclede representative. Or write to *Laclede-Christy Works, Refractories Division, H. K. Porter Company, Inc., Porter Building, Pittsburgh 19, Pa.*

REFRACTORIES PORTER DIVISION

H.K. PORTER COMPANY, INC.

Divisions: Connors Steel, Delta-Star Electric, Disston, Forge & Fittings, Leschen Wire Rope, Mouldings, National Electric, Refractories, Riverside-Alloy Metal, Thermoid, Vulcan-Kidd Steel, H. K. Porter Company (Canada) Ltd.

For more data circle 518 on Post Card

selection charts, tables, and piping diagrams are provided to assist in selection of units to meet various requirements. Industrial Div., American-Standard.

155 Shot Cleaning System — Bulletin 2145 describes a shot cleaning system for removing soot and ash deposits from horizontal superheaters, economizers and reheaters as well as internal surfaces of tubular air heaters. Typical system is pictured. Diamond Power Specialty Corp.

156 Flow Check Snubber — A flow check snubber which isolates instrument from pressure transmitting medium is described in this bulletin. Construction of parts are diagrammed and explained, and instructions for assembly of flow check snubber into pressure instrument system included. Chemiquip Co.

157 Chemical Analysis System — Described in this 8-pp brochure is the AutoAnalyzer, an automated system for continuous chemical analysis, that can analyze trace materials down to parts per billion, continuously record results. Principles of operation and system's components are detailed, industrial applications listed, and specific analysis for a variety of trace materials noted. Technicon Controls, Inc.

158 Rubber Parts, Products — Eight-pp Form 237C, in file folder form, describes company's facilities for producing custom-made rubber parts, seals and components. Facilities for developing natural, synthetic and silicone compounds, fabricating techniques and a showing of representative products and services provided. Goshen Rubber Co., Inc.

159 Purifiers, Scrubbers — Bulletin 601 describes company's purifiers, scrubbers, mist extractors and separators for natural gas and petroleum industry. Detail drawings, size data, applications and photos are provided for all types. Four principal liquid and dust type scrubbers are catalogued. The V. D. Anderson Co.

160 Metal Gaskets — Design, construction and utility of company's spiral wound metal gaskets is detailed in 12-pp Bulletin AD-104. Details particular features of metal gaskets and lists various types available for special applications. Includes dimension tables and specifications. The Garlock Packing Co.

161 Flexible Hose — Advantages of flexible hose in air handling and fume control applications are detailed in 20-pp Bulletin 83. Material specifications and selection data are included and typical applications are illustrated in a series of photo case histories. The Flexaust Co.

162 Story of Coal — This pocket-size booklet presents a complete picture of company's operations, traces the history of the coal industry and describes the many services and applications of coal. A colorful mural reproduced in the booklet pictures the part coal has played in civilization. Peabody Coal Co.

163 All-Purpose Engines — This 12-pp illustrated brochure describes industrial and other engines available in company's all-purpose power line. Gives power ratings and overall dimensions on over 100 in-line, "V" and turbopower engine models. Detroit Diesel Engine Div., General Motors Corp.

164 Butyl Rubber Compounds — Resistance of butyl rubber to ozone is

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Each of these men is a highly-trained technical specialist in the field of heat transfer. If you have a problem concerning such things as design, surface area, corrosion, alloy selection, where and when it is advantageous to use integrally-finned tube, etc.—don't hesitate—give the one nearest you a call. You can depend fully on his heat transfer knowledge, particularly where tubing is concerned.

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ELLIOTT air magnetic tube expander drives

automatically controlled for fast, accurate tube rolling

Designed for faster, precision tube rolling, the standard model Elliott Air-Magnetic drive is setting new records for speed and accuracy. Some operators average 12 tubes per minute. Desired torque easily preset by rotating forward end of unit. No tools needed. Rolling stops when preset torque levels are reached. Includes trigger-controlled, explosion-proof air motor in single unit. Magnetic control, no springs. Balanced for easy handling. For tubes ¼ in. through 3 in. *Standard model* handles most jobs. *Heavy-duty* for higher torque.

ALSO Electric Control ... Tube Expanders ... and Related Accessories

Elliott offers the Automatic Electric Control—an accurate torque-limiting device designed for tube expanding with any standard tapping motor. Also, a complete line of tube expanders, with rotating, parallel, self-feeding rolls. Available in 4 sizes, ranging from ¼ in. to 3½ in. O.D.

Other related accessories include Elliott tube gage, tube plugs, tube pilot, and tube rolling lubricant.

Write for descriptive literature *today*.

Y9-3

ELLIOTT Company
LAGONDA PLANT, Springfield, Ohio

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evaluated in 12-pp Bulletin 105-1. Tables of data show test results for both mold- and steam-cured compounds. A second study, Bulletin 102-1, demonstrates resistance of butyl rubber to a number of commercial fire-resistant hydraulic fluids. Tables and graphs are included illustrating effects of immersion temperature on volume swell and physical properties of butyl rubber. Thiokol Chemical Corp.

165 Glass Cloth — Five bulletins describing woven-glass-base insulating tapes and fabrics are available from the company. The bulletins describe properties and applications of glass tapes, fabric sheets, wrappers and die cut pieces, both silicone-varnished and rubber-coated. Each bulletin includes, in tabular form, complete information on properties. Continental-Diamond Fibre Corp.

Bulletins reviewed here are offered primarily for qualified power engineers. Manufacturers may withhold literature from persons who do not state their job title and company. Some manufacturers also prefer not to send literature to those in foreign countries in which they have no sales representatives.

166 Magnetic Amplifiers — Bulletin S-921 describes low level linear magnetic amplifiers for use in connection with such signal sources as strain gage transducers, thermocouples, resistance thermometer bridges, photo cells and meter shunts. Performance specifications, data on principles of operation furnished. Magnetic Amplifiers, Inc.

167 Flame Safeguard — Features of company's continuous check flame safeguard are presented in Specification S1015-5. Illustrated sheet covers construction, operation, and applications of the unit in detail. Minneapolis-Honeywell Regulator Co.

168 Polyethylene Corona Effects — A study of the effects of corona on polyethylene is presented in this 28-pp research booklet of interest to power engineers concerned with wire and cable insulated with polyethylene. The report is based on 200,000 sample exposure hours, designed to determine effects of corona on polyethylene in order to provide the industry with insulation free of these effects. E. I. du Pont de Nemours & Co., Inc.

169 LMTD Chart — An often disliked chore — that of finding the logarithmic mean temperature difference — has now been simplified with an easy-to-use LMTD chart. Consisting of three columns, it is only necessary to connect the initial temperature difference with the final difference and note the intersection of this line with the middle column which gives the LMTD. Dean Thermo-Panel Coil Div., Dean Products, Inc.

170 For Water, Waste Treatment — Catalog 952 contains 64 pp of comprehensive information on water and bar screens, grinders, collectors, settling tanks, scum removers, controlled flocculation, feeders, conveyors, bucket elevators, chains and sprockets for water, sewage and industrial waste treatment. Drawings, charts and installation photos supplement the copy. The Jeffrey Mfg. Co.

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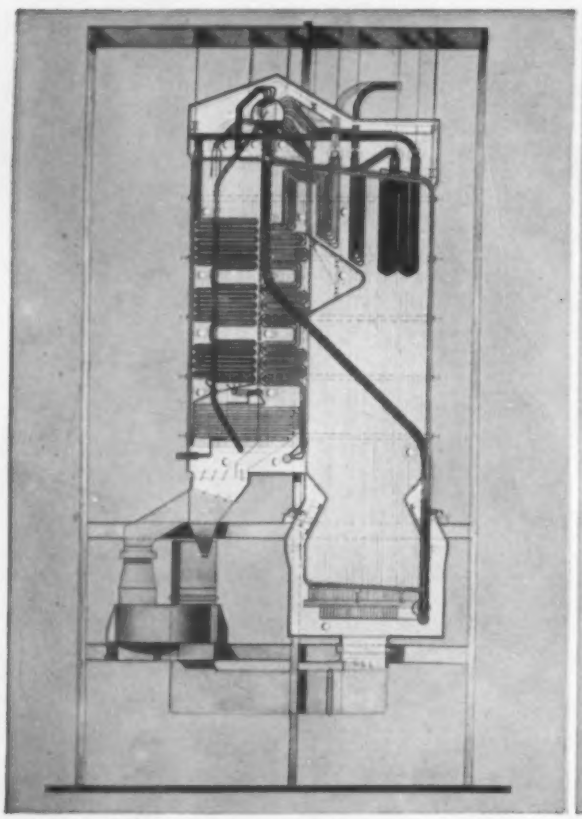
—the pipe insulation that's worth more money

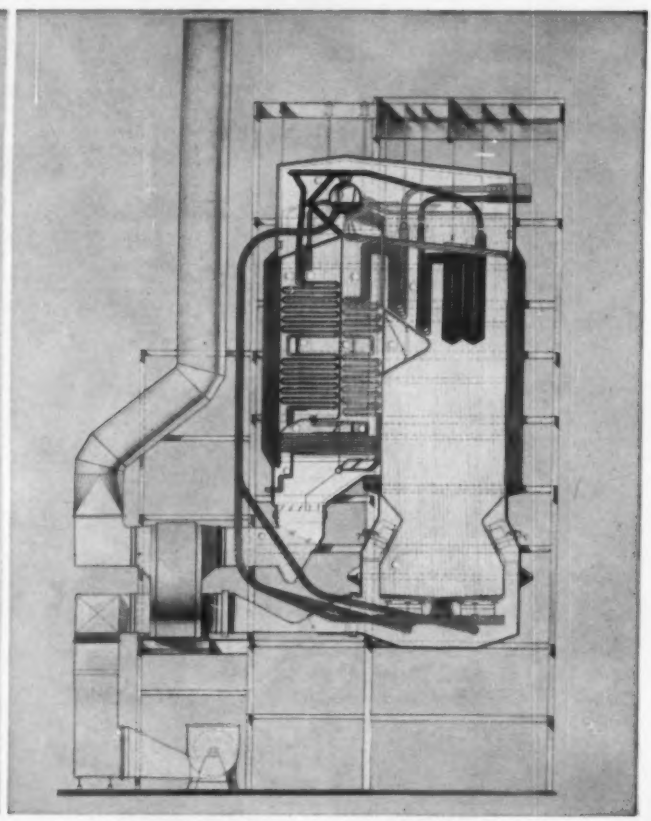
There's never a peep from installation or maintenance crews—or from the front office—when UNIBESTOS is specified. It cuts and fits easily...goes-on faster...takes all the heat it's designed for. Sizes to 44" o.d. Temperatures to 1200°F. Write for Catalog F76-321 with exclusive "J" Factor Tables. Union Asbestos & Rubber Company, General Sales Offices: 1111 W. Perry St., Bloomington, Illinois. Distributors in principal cities.

NOW Is The Time To Order New Steam Generating Capacity

A new era of growth in the field of power generation is approaching . . . an era that promises to greatly increase the demand on manufacturers of steam and electrical generating equipment. Riley Stoker Corporation, having successfully met the challenge imposed by the remarkable growth of the past decade is now thoroughly prepared to meet the even greater challenge of the new era. Riley is fully staffed and manned in both engineering and manufacturing divisions. Orders placed NOW will be processed efficiently and quickly. Avoid the competition for delivery that may result if the inevitable order is delayed to a time when late delivery may result.

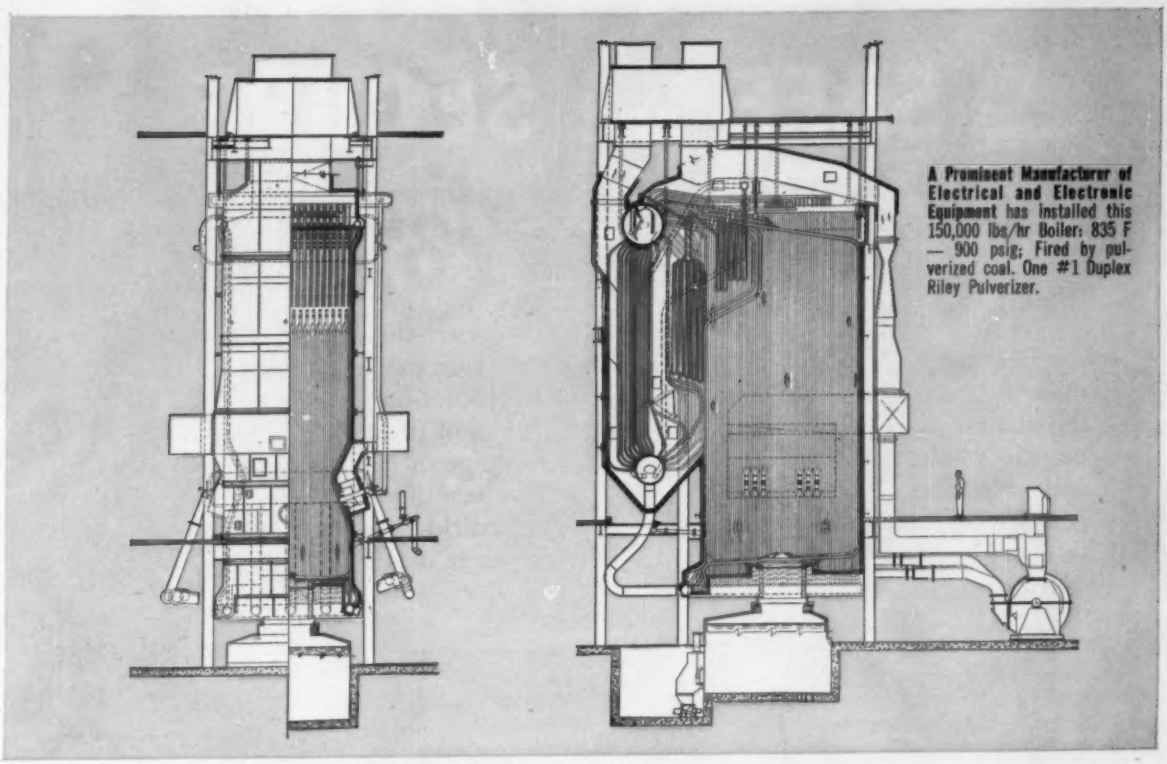


TURBO FURNACE Reheat Unit for **Florida Power Corporation** has capacity of 600,000 lbs/hr. 1750 Psi, 1000/1000 F. Fuels: oil, gas. Could convert to coal with minimum outage. **Black & Veatch.**



This Riley **TURBO FURNACE** Reheat Steam Generator for **Dallas Power & Light Company** is pressurized, has a steam capacity of 1,200,000 lbs/hr. 1005/1005 F. 2125 Psi. Will burn gas and oil initially and convert readily to lignite, coal in future. **Ebasco Services, Inc.**

RILEY — *A One-Stop Source For Both Steam Generating And Fuel Burning Equipment*



A Prominent Manufacturer of Electrical and Electronic Equipment has installed this 150,000 lbs/hr Boiler: 835 F — 900 psig; Fired by pulverized coal. One #1 Duplex Riley Pulverizer.

TURBO FURNACE BOILERS THOROUGHLY FIELD TESTED

With the Riley Turbo Furnace thoroughly field tested you can specify the Riley Turbo Furnace Boiler with full confidence that it will live up to its superior performance characteristics. Turbo Furnace Boiler Designs are supplied with Reheat and Non-Reheat and with pressurized and non-pressurized furnaces.

RILEY BOILERS GIVE SUPERIOR PERFORMANCE WHEN EQUIPPED WITH COMPLETE RILEY FUEL BURNING SYSTEMS

Any fuel or any combination of fuels can be burned efficiently with Riley Boilers because Riley also manufactures a complete line of fuel burning products. For pulverizing coal Riley offers two types of mills: the Riley Pulverizer and the Riley Ball Tube Mill. These are used with either Riley Flare Type Gas/Oil/Coal Burners with Riley wall fired units, or with Riley multiple fuel Directional Flame Burners with the Turbo Furnaces. Riley also furnishes spreader stokers, traveling grate stokers and underfeed stokers. A Riley Boiler installation complete with Riley fuel burning equipment assures a contract of undivided responsibility.

RILEY PROVIDES FULLY EQUIPPED AND SKILLED CONSTRUCTION SERVICES

Riley Stoker Corporation supplies complete construction services with its equipment. Riley construction crews employ the latest in construction methods and techniques.

EXPERIENCED SERVICE ENGINEERS ASSURE SAFE, DEPENDABLE AND EFFICIENT OPERATION OF RILEY BOILERS

Riley Service Engineers are trained to provide prompt and efficient servicing of all Riley installations. These experienced engineers work closely with your operators to assure that your Riley equipment will operate at high efficiency for long uninterrupted periods of operation.

YOU'LL FIND A RILEY REPRESENTATIVE IN EACH OF THESE PRINCIPLE CITIES:

Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, Seattle, St. Louis, St. Paul, Syracuse, Worcester.

A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

For more data circle 522 on Post Card

SAFE and SECURE

Ric-wiL Underground Piping Systems are safe and secure from tornadoes and hurricanes . . . virtually unaffected by surface weather conditions. In recent years, changing weather patterns have brought severe storms to areas in the United States that had never before experienced them. Ric-wiL Underground Systems remained unharmed . . . and in an emergency situation, immediate heat can be an important factor in restoring operations as quickly as possible.

Ric-wiL Systems have been proven by installations totaling more than 8,000,000 lineal feet. They are completely prefabricated and shipped to the job sight ready for installation. Production time and delivery can be definitely predetermined.

Write, wire or phone for information on the many types of Ric-wiL Systems available.

Send for new revised catalog.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

SINCE 1910

RIC-WIL INCORPORATED — PREFABRICATED INSULATED PIPING SYSTEMS

See our catalog in Sweets

BARBERTON, OHIO

IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

For more data circle 523 on Post Card

6 Ljungstroms® go to work for the city of Memphis ...and so does lifetime Air Preheater service

The City of Memphis Light, Gas and Water Division has just installed three boilers served by six Ljungstrom preheaters. Why Ljungstrom preheaters? One reason is service. Air Preheater engineers don't just wait for a call. They regularly inspect and help maintain Ljungstroms *through the life of each unit.*

What's more, Air Preheater provides rapid *factory* service in an emergency. Here's an example. A customer phoned on a Friday morning for a replacement trunnion—a major integral part of the preheaters. His Ljungstrom was 17 years old, which meant that a new trunnion had to be custom made to match his older-style. He was located 500 miles away. And he needed his boiler back on the line by Sunday.

Air Preheater went to work. Special trucking was arranged. The job was done *and shipped* that same evening. The customer had the trunnion by Saturday morning and the boiler was back on the line by Saturday evening!

Fast response to emergencies and regular inspection of Ljungstrom installations are two of the many advantages Air Preheater provides its customers. Another is expert knowledge of boiler and preheater problems —and how to lick them—gained from over 35 years of experience. Perhaps these reasons explain why 9 out of 10 preheaters sold today are Ljungstroms. For further information write today for free illustrated brochure.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

Ljungstrom rotor being installed for the City of Memphis Light, Gas and Water Division. Six such Ljungstroms—each with 201,400 sq ft of heating surface —will serve three boilers. The boilers will each evaporate 2,000,000 lbs of steam/hr and have a combined nameplate capacity of 750,000 kw. A fourth boiler unit is now under consideration. Burns and Roe, Inc. designed and supervised construction.

NEW EDWARD IMPACTOGEAR

What's New from Edward Valves

New Products . . . Solutions to Problems . . . Information on Steel Valves from Edward, Long-Time Pioneer in the Field!

How Impactogear* operates high-pressure valves

You no longer need a crew of men to open or close big, high-pressure valves. New Edward Rockwell-built Impactogear makes big-valve operation a quick and easy job.

FAST AND EASY "RUNDOWN"

Your operator simply applies portable air or electric wrench to pinion shaft-end of Impactogear. When power is applied, pinion turns ring gear, which turns handwheel and moves the stem to "closed" position. Impactor* handwheel then gives final tight shut-off with unique "hammer-blow" action. (Tests show it delivers 12 times the closing force of ordinary handwheels—with less effort!) Impactogear works quickly, can operate a 2500-lb 10" valve (for example) in only 2¼ minutes. And Impactogear can be fitted to any 8" or larger Edward valve of 900-lb (or higher) pressure class.

IMPACTOGEAR WITH AIR WRENCH

Impactogear utilizes standard portable air or electric wrenches generally available throughout industry. Example below shows how two typical air wrench ratings can be applied:

Wrench Type No. 1—Stall torque 170 ft-lbs: Free speed 225 rpm; Weight 12 lbs

For 12" and 14" 2500 lb. valves, operating pressures to 3500 psi

For 10" 2500 lb valves, all allowable operating pressures

For 10", 12" and 14" 1500 lb valves, all allowable operating pressures

For 12" and 14" 900 lb valves, all allowable operating pressures

Wrench Type No. 2—Stall torque 200 ft-lbs: Free speed 300 rpm; Weight 38 lbs

For 12" and 14" 2500 lb valves, operating pressures 3500 psi to 4500 psi

IMPACTOGEAR WITH ELECTRIC WRENCH

Portable electric wrenches are equally practical. Example below shows a typical electric wrench rating as applied to Impactogear:

Wrench Type No. 1—Stall torque 176 ft-lbs: Free speed 225 rpm; Weight 44 lbs

For 10" 2500 lb valves, all allowable operating pressures

For 10" and 12" 1500 lb valves, all allowable operating pressures

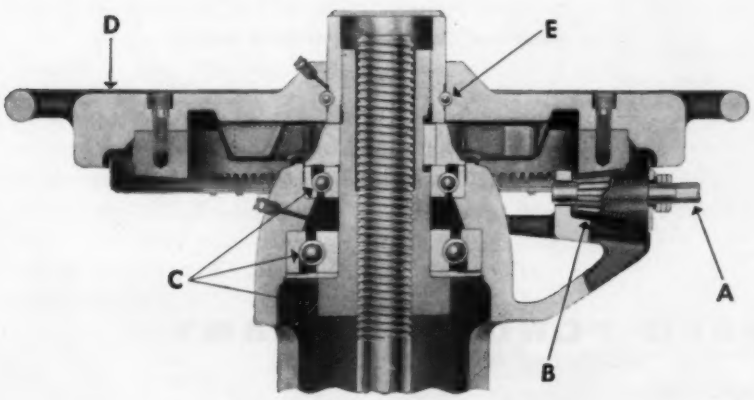
For 12" and 14" 900 lb valves, all allowable operating pressures

SLASH COST OF VALVE OPERATION

Individually installed operating motors are a big investment. They can add as much as 100% to the basic valve cost. *But now you can save that money by standardizing on Impactogear*—radically simple, thoroughly dependable mechanism utilizing *existing* compressed air or electric facilities. Your Edward Representative will be glad to provide full details and help you determine how Impactogear can work to your best advantage. Contact him—or write *Edward Valves, Inc., 1202 W. 145th Street, East Chicago, Indiana.* (Subsidiary of Rockwell Manufacturing Company). Represented in Canada by Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W., Montreal 1, Quebec.

LIGHTWEIGHT PORTABLE WRENCH can operate as many Impactogear-equipped valves as desired. Or, each valve can be fitted with its own wrench. Either way, you get lower operating costs. Final closing is effected by handwheel lugs (A) striking hammer blows against cross arm keyed to yoke bushing (B). Half of gear cover was removed for illustration purposes.

*T.M. Reg. U.S. Pat. Off.



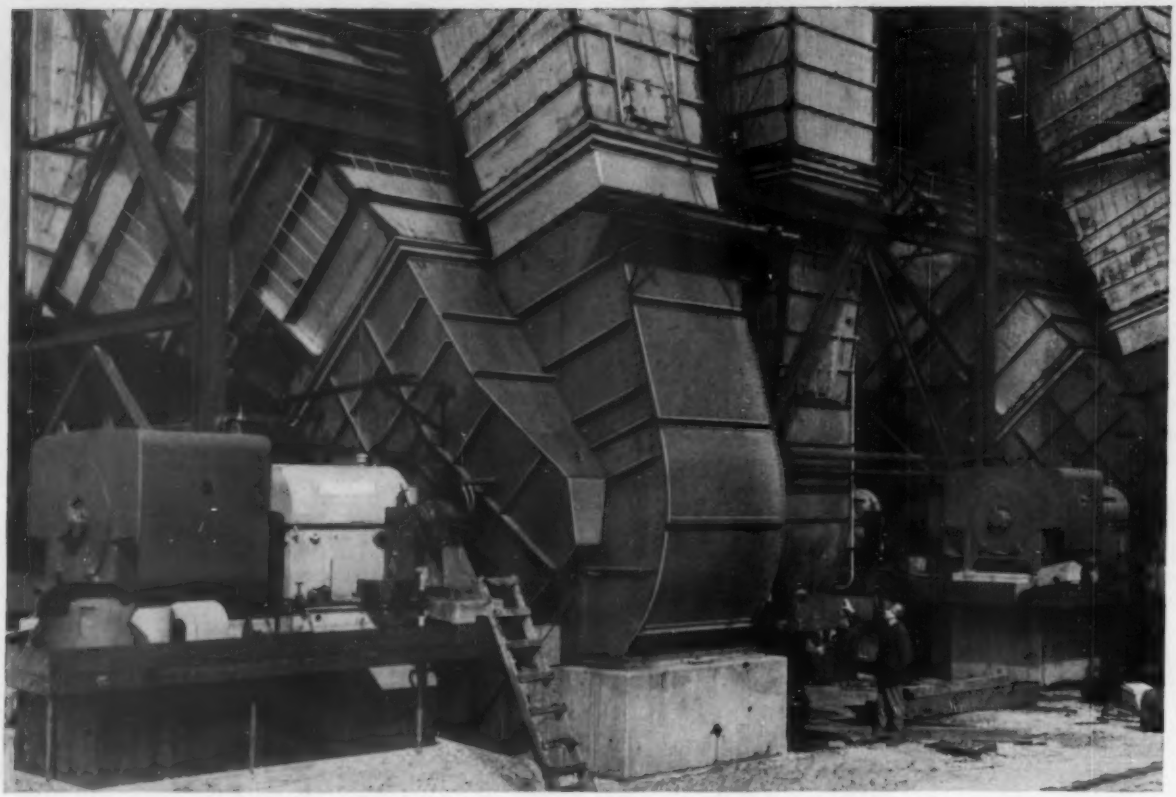
Details of new Impactogear and Impactor Handwheel:

A—Hex head of pinion gear shaft. Power wrench is applied here. B—12-to-1 bevel gear ratio is typical for median size handwheel. C—Exclusive EValthrust yoke bushing combines radial and thrust bearings for easy operation and long life. D—New Impactor handwheel concentrates mass near outer circumference for maximum impacting efficiency. E—New extra bearing increases operating efficiency.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

Catalog 14 contains full data on the complete Edward line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets, with screwed, welding or flanged ends.

For more data circle 525 on Post Card



LOOKING FOR PEAK EFFICIENCY OVER BROAD RANGE FOR YOUR DRAFT FANS?

Here's Why "Buffalo" "BLH" is Best Answer:

The "Buffalo" Family of "BLH" Fans is designed for highest mechanical efficiency over an extremely broad operating range. Peak efficiencies are up to 86%. Rugged "Buffalo" construction insures economical, dependable operation throughout a long, trouble-free life.

"Buffalo" Type "BLH" features include: streamlined housing designed to deliver ultra-smooth air flow, peak static conversion and pressure distribution at outlet — turbulence minimized by smooth inlet bell, directional inlet vanes, backward-curved blades, matching rotor flange and inlet bell and gradually divergent outlet. These features all add up to the quiet, powerful, smooth performance characteristic of the "BLH".

Reliable, maintenance-free operation is the result of extra-heavy construction throughout. This includes sturdy steel plate construction ruggedly welded for extra strength — oversized shafts and bearings. Rotors are statically and dynamically machine balanced at factory.

If your mechanical draft conditions require a dependable fan that provides high efficiency over a broad operating range, ask your "Buffalo" engineering representative for complete facts about the "Buffalo" family of mechanical draft fans. Or you can write us direct for Bulletin FD-905.

BUFFALO FORGE COMPANY
Buffalo, N. Y.
Buffalo Pumps Division • Buffalo, New York
Canadian Blower & Forge Co., Ltd., Kitchener, Ontario

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT • EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING

For more data circle 526 on Post Card

A plant built on the philosophy of "don't accept anything at face value"...

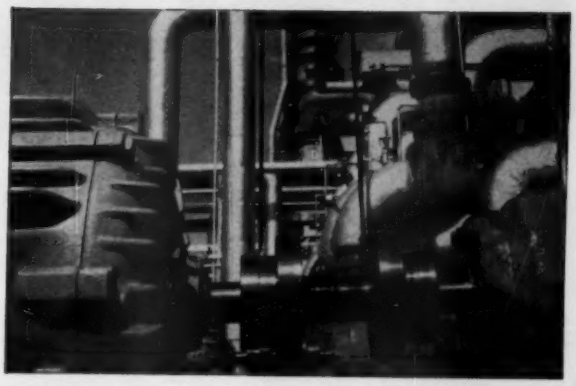
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

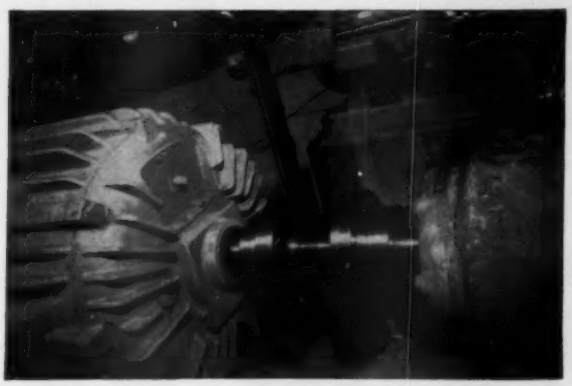
Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 5205 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.



This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

Engineered Products
Sold with *Service*

KOPPERS

THE ORIGINAL
FAST'S Couplings

For more data circle 527 on Post Card

DE LAVAL STEAM TURBINES

for process industries

The photograph above shows a De Laval direct-connected turbine generator installation at Parke, Davis & Co., Detroit, Michigan.

This controlled extraction, controlled back-pressure unit supplies 2000 kw using process steam. Extraction is at 130 psig, exhaust is 5 psig. This new machine was added to already existing De Laval units that have been in service for 30 years. In addition, the Parke-Davis Research Laboratories in Ann Arbor, Michigan will soon be using a new 1000 kw unit.

Parke, Davis & Co. uses DE LAVAL Steam Turbines for process and power generation

Proved economy, dependable service

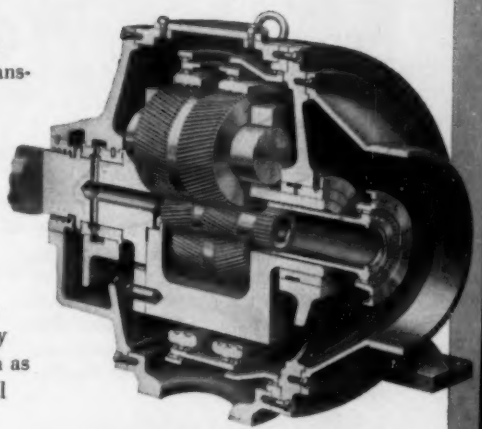
In many process industries, an important by-product is economical electric power. If appreciable quantities of process steam are used, power generation can be achieved at comparatively low cost.

De Laval, pioneer in high speed rotating machinery, has continued to maintain engineering and manufacturing leadership. If you have process application where low-cost power generation can be utilized, call on De Laval.

De Laval-Stoeckicht Planetary Gears

In many applications where high speed and high horsepower are transmitted, the De Laval-Stoeckicht planetary gear can be used to great advantage. It is also used as a speed increaser or decreaser in many industrial installations.

Among its outstanding characteristics are light weight, in-line construction and space saving. It may be used for all kinds of drives such as gas turbines, steam turbines, diesel engines, etc.

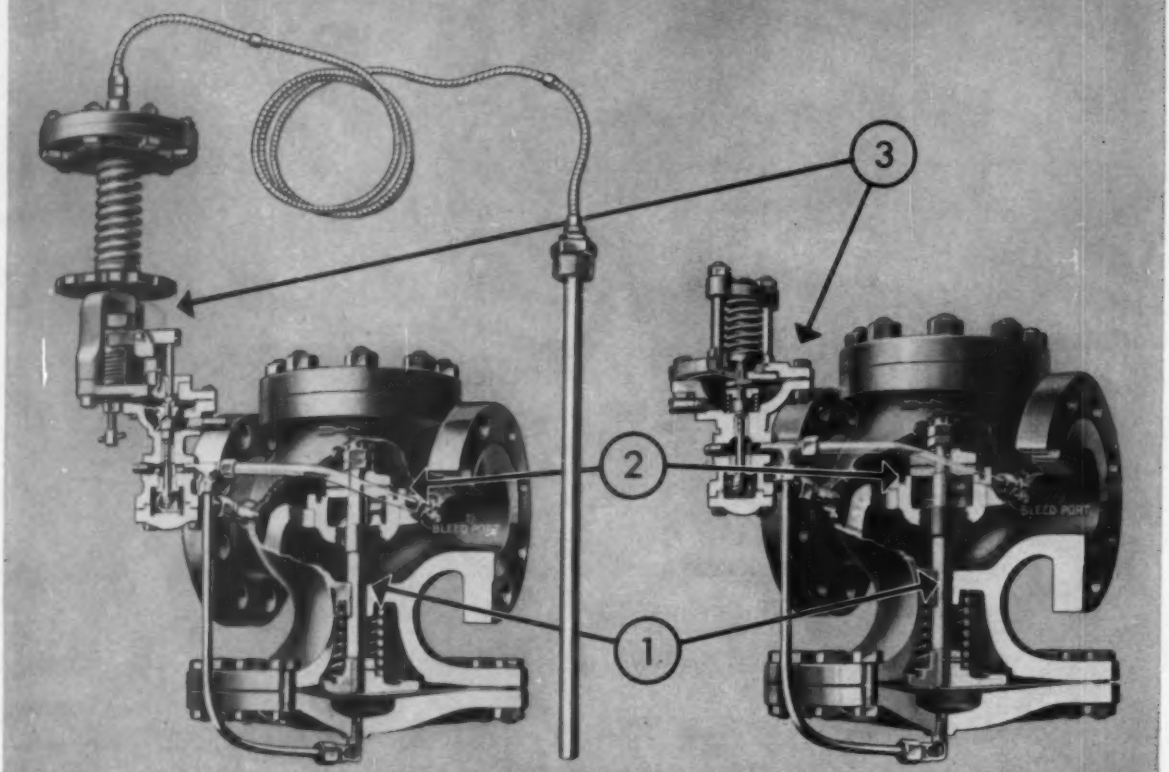


Write for Bulletin 2400

DE LAVAL *Steam Turbine Company*

816 NOTTINGHAM WAY, TRENTON 2, N. J.

3 Tips for Low Maintenance in Automatic Regulating Valves



Spence ET124 Temperature Regulator

Spence ED Pressure Regulator

No engineer has to be told that downtime of regulating valves is costly—and a nuisance.

Nowadays the men who keep these valves operating want to make sure they aren't stuck with a maintenance headache for the life of their valves. That's why we are outlining this simple check list which covers three important features which keep maintenance costs down.

1. Stuffing boxes are probably the number one time consumer in valve maintenance. No matter how you figure it, repacking stuffing boxes is costly.

That's one reason Spence uses a "balanced" diaphragm construction which eliminates stuffing boxes. Simple stem guiding and large metal diaphragm operation reduce sticking and binding to a minimum.

2. Another problem is replacement of seats and discs when they've been cut by steam. Today you can forget about this problem entirely by insisting on an unconditional guarantee against wiredrawing. Spence, for instance, uses SECO Metal seats and discs and gives such a guarantee.

3. Any valve designed to control temperature and pressure within tight limits can be affected by dirt in the steam lines. You can't get a guarantee against this, but you can specify a valve that makes trouble shooting easy. Here's the tip:

Make sure your regulating valve is controlled by an external pilot. If trouble develops, it is easy to find out if it is in the pilot or the main valve with a simple test.

If the trouble is in the pilot, you can remove it without taking the main valve out of the line.

The quickest way to get the regulator working again is to install a spare pilot. This is easy—and in the Spence design it is not expensive to carry spare pilots. Spence pilots fit all sizes of Spence main valves.

These maintenance advantages plus other advanced features are available in a wide range of Spence automatic regulating valves. For more information write for the Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

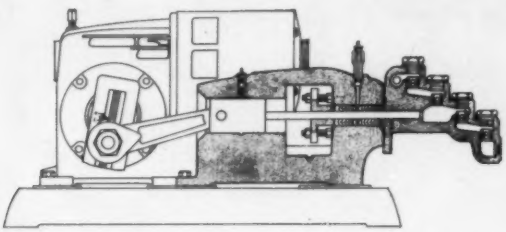
SE-144

For more data circle 529 on Post Card

HOW TO METER ACIDS ACCURATELY AGAINST PRESSURE

Corrosive liquids present two major obstacles to achieving maximum metering accuracy, economy, and safety. For one thing, corrosion can introduce an intolerable ever-changing volumetric error. For another, corrosive liquids must be retained by the pump at all times. Leakage can endanger personnel and necessitate the premature replacement of pump parts and associated equipment.

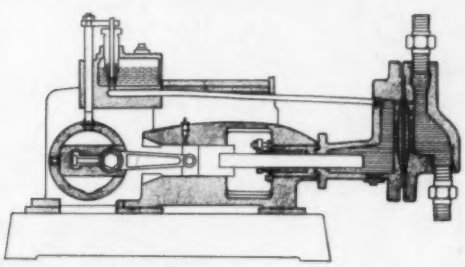
But both obstacles can be successfully overcome. First by choosing the right pump for the metering job at hand. Second, by making sure that all wetted parts of the pump chosen are inert to the liquid being metered. Here are some ideas based on practical acid metering experience that may help you to choose the one best controlled volume pump for your metering needs.



Packed Plunger Pumps

For the majority of mildly corrosive liquids, low cost packed plunger pumps have proved themselves entirely adequate. Some thirteen materials of construction are *standard* on packed plunger pumps, running from cast iron to Hastelloy B and C, more than enough to satisfy mild corrosive metering requirements. Capacities to 2056 gph, pressures up to 50,000 psi.

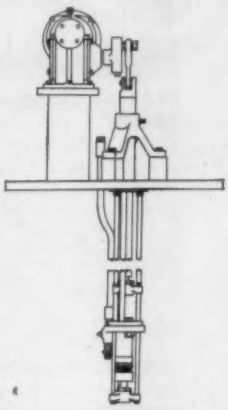
An added tip: Standard Milton Roy motor driven pumps in corrosive service can be equipped with "catch-all" yoke type gland followers.



Diaphragm Liquid Ends

When the liquid to be metered is highly corrosive or otherwise dangerous, a controlled volume pump with diaphragm liquid end is the best choice. A plastic or stainless steel diaphragm positively separates the process liquid and the plunger. The plunger displaces a hydraulic fluid which in turn strokes the diaphragm to create pumping action through the ball checks. Consistently high accuracy is achieved through unique design features. As the illustration shows, positive mechanical action bleeds any air or vapor from the hydraulic side between strokes and corrects liquid volume if necessary. Internal liquid end design also automatically eliminates bubbles from the process liquid side.

Very often, a pump chosen for mild corrosive service is obsoleted by a process change specifying a more highly corrosive liquid. But this waste is neither necessary nor desirable. The diaphragm liquid end illustrated can easily be substituted for the conventional liquid end on any standard motor driven controlled volume pump, bringing the entire metering system up to date at little extra expense. *Designs of this type will handle up to 400 gph against heads to 2700 psi.*



Totally Immersed Liquid Ends

Special metering problems demand special pump designs. For example, acids with high vapor pressure or high specific gravity must be pumped with limited suction lifts and generally require suction heads. The ideal answer is the standard Mersemetric® controlled volume pump. Pump drive and motor are mounted on the tank top, but the liquid end is completely submerged to a depth of up to fourteen feet. This same design feature also eliminates the need for tank connections below liquid level, and permits chemicals to be metered *directly* from storage.

The maximum safety-minimum handling Mersemetric design is just about standard for metering sulfuric acid for demineralizer regeneration and pH control of cooling tower water and deaerator effluents. *Capacities up to 218 gph, pressures up to 1200 psi.*

The Acid Metering System

You can be fairly sure of making the right choice only if you consider *all* the factors. Here's a convenient checklist of a few points that are often overlooked:

- Is the entire *system* corrosion-resistant . . . storage tank, suction and discharge piping, controlled volume pump, and relief valve?
- Have you thoroughly considered the physical properties of the liquid? High vapor pressure or high specific gravity liquids may demand a suction head.
- Have you considered plant and personnel safety under all possible conditions?
- Have you considered maintenance as well as first cost in determining the economics of the system?

If precision pumping of dangerous chemicals is one of your problems, look again to Milton Roy's 25 years of experience for your most economical solution. Write for a general introduction to controlled volume pumping in Bulletin 553-1. Milton Roy Company, 1300 East Mermaid Lane, Phila. 18, Pa.

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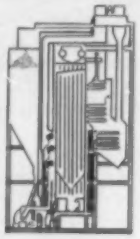

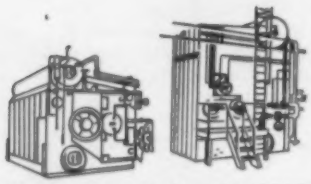

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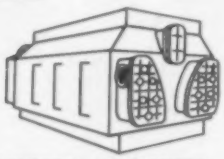

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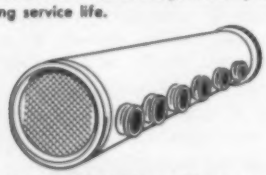

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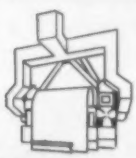

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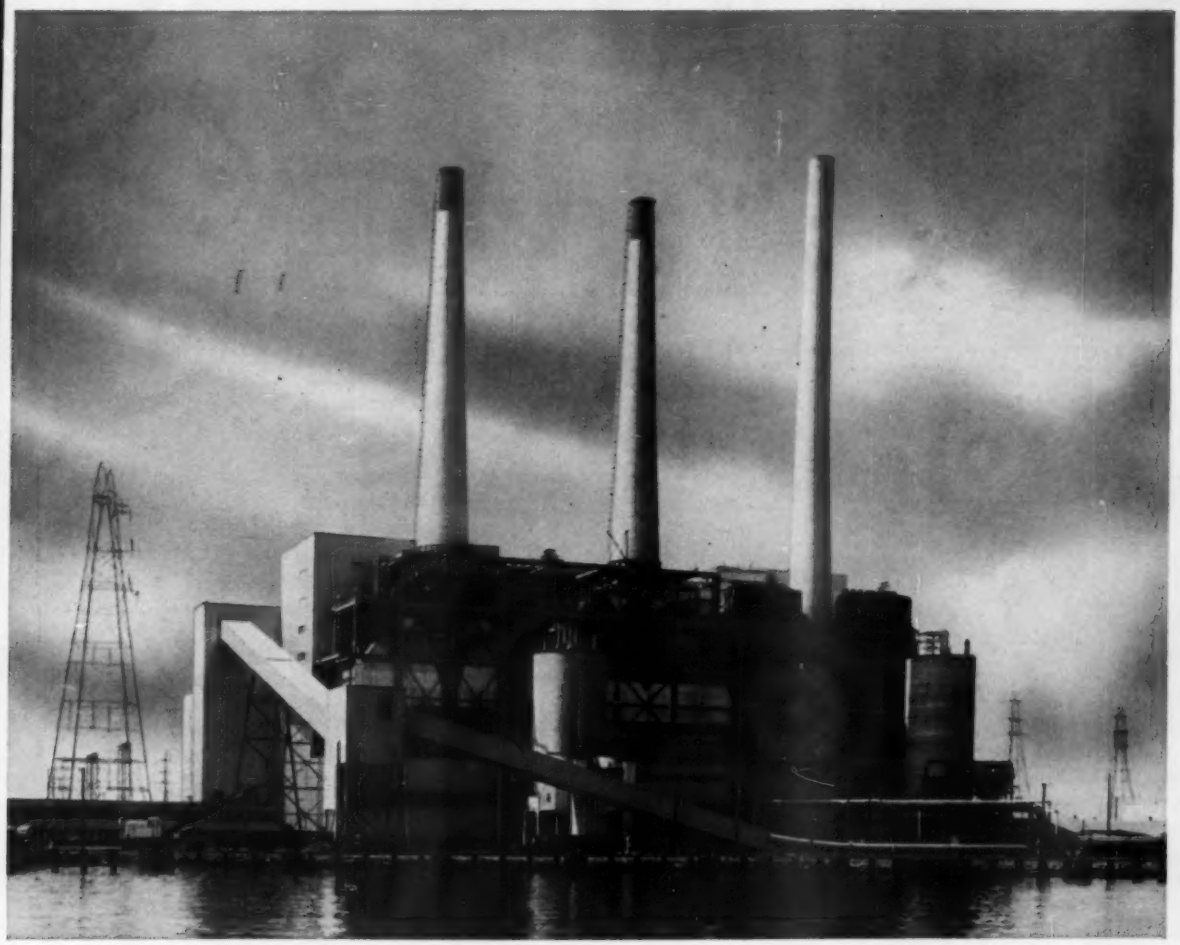

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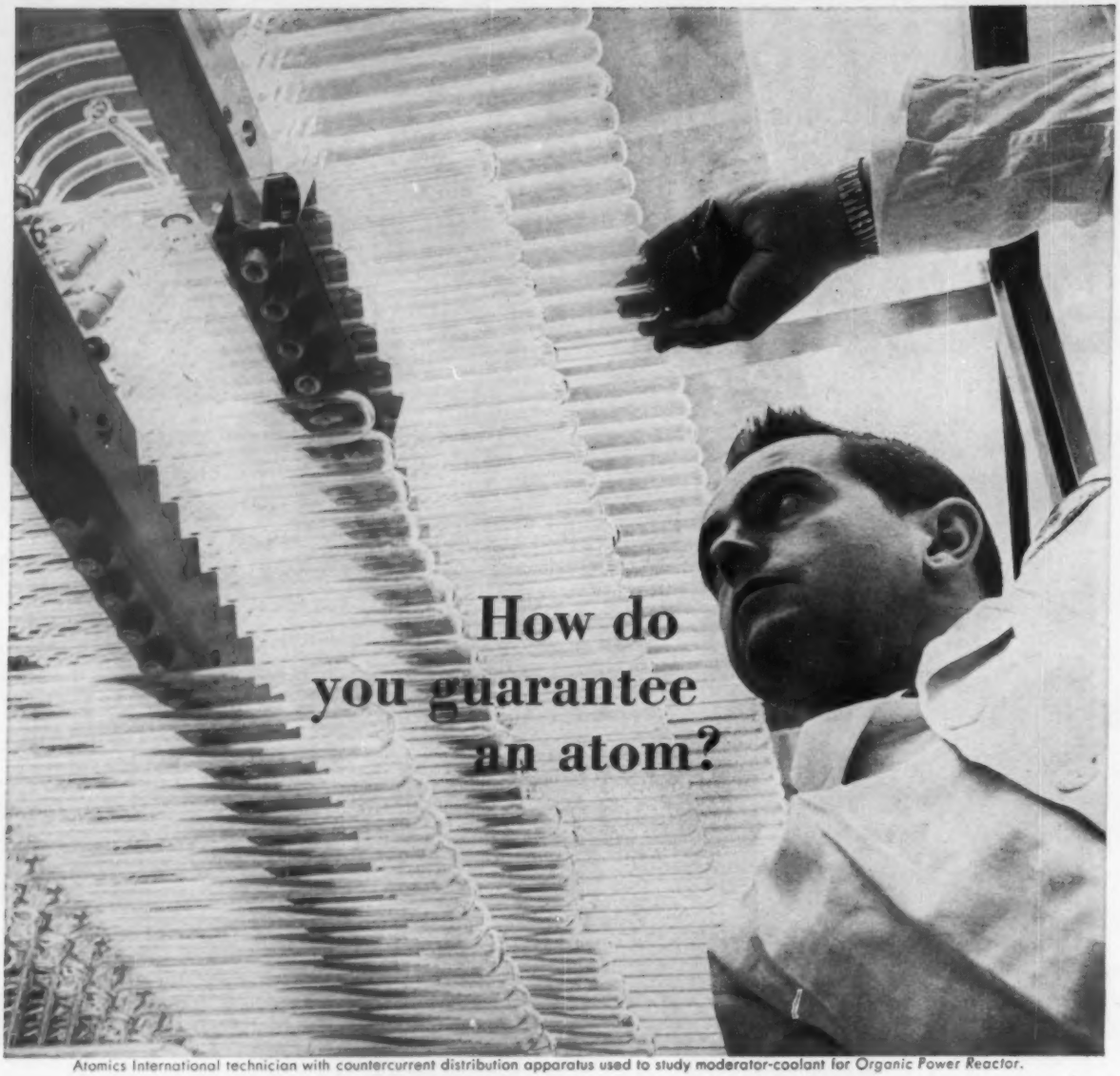

Atomics International technician with countercurrent distribution apparatus used to study moderator-coolant for Organic Power Reactor.

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A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World Published by Technical Publishing Co.

May 1959

Globe of Sulfur. Some 300 years ago, sometime around 1663, Otto von Guericke constructed a primitive electrical machine, consisting of a globe of sulfur, fixed on an axis and rotated by a winch. It was excited by the friction of warm hands held against it. This first electrostatic generator with its strange sparks excited great interest among the learned people of the day. It was the beginning of the science of electrostatics and von Guericke's machine was the forerunner of a long series of machines developed by different inventors during the following two centuries.

It was not until 1878, however, that a really improved type of electrical machine was invented. This was the so-called influence machine invented by James Wimshurst, which threw all other electrostatic machines in the shade. It consisted essentially of two glass discs revolving in opposite directions on which were glued tinfoil inductors. Wimshurst constructed powerful machines of this type which delivered a torrent of sparks whenever the winch was turned. In the early years of this century large Wimshurst machines with multiple plates were often used instead of induction coils to excite X-ray tubes in medical work.

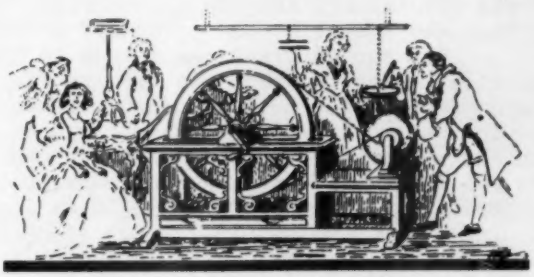

Fig. 1 Otto von Guericke

With the development of electrodynamics, however, interest in electrostatics waned, and until quite recently electrostatic machines remained largely a matter of laboratory curiosity — equipment not considered of particular practical application. One advantage that the Wimshurst machine had over the induction coil in the excitation of X-ray tubes was that it delivered a constant potential, and direct current is more suitable for X-ray tubes than alternating current.

With the development of the high-voltage rectifying tube around 1920 this situation changed. By means of transformers and rectifying tubes, high voltage direct current sources could be made and these gradually replaced all other equipment used in X-ray power supplies. Similar high voltage d-c sources were developed for radio transmitters, and in time, this type of power supply replaced the "A" and "B" batteries used in the early radio receivers.

Particle Accelerators. It was quite natural, therefore, that in the late 1920's, those interested in accelerating nuclear particles in nuclear bombardment investi-

gations, should have turned to this type of voltage supply for producing high speed particles.

Until that time studies involving the bombardment of atomic nuclei were carried on by the use of high speed particles emitted in the disintegration of radioactive elements such as radium, polonium, and other natural radioactive sources. In most of this early work the alpha particles from natural sources were used. In 1928, however, George Gamow suggested that other charged particles might be more effective, first because the energy barrier was lower but also the probability of penetrating it was increased as the charge and mass of the incident particle decreased. Of course, a small number of fast-moving protons are ejected in certain types of natural radioactive disintegrations but the number is so insignificant as to be useless for practical purposes.

Interest was therefore aroused in many scientific laboratories in the possibility of developing methods for building up high potentials of the order of hundreds of thousands — perhaps even millions — of volts, whereby protons could be accelerated to sufficient speeds to penetrate atomic nuclei.

Cockcroft-Walton. The first success in this direction was attained by Cockcroft and Walton at Cambridge, England in 1932. Their work stands out in the history of nuclear science as being the first case of nuclear disintegration brought about by purely artificial means. (See ATOMICS, July 1, 1955.) They used an accelerating voltage of 125,000 volts in their early work but later on they attained potentials of nearly 800,000 volts, by means of voltage multipliers. These consisted of arrangements of capacitors and vacuum tube rectifiers in which the capacitors were charged in parallel and then discharged in series.

Van de Graaff. While the voltage multiplier is effective for comparatively low high-voltages, it has definite limits for voltages measured in millions. So about the time that Cockcroft and Walton were doing their work, a man appeared upon the scene who reached all the way back to old Otto von Guericke to improve the situation. This was Robert J. Van de Graaff at MIT in the United States.

Dr. Van de Graaff went back to the old electrostatic principle — frictional electricity. Indeed, his machine was absurdly simple; it was nothing more than a non-conducting belt running over two pulleys and driven by an electric motor. The belt carried positive charges to a metal sphere at the top of the belt, and on the way down it carried negative charges to the ground. In his first machines Van de Graaff attained a maximum potential of 1.5 million volts but in later forms this was carried up to 10 million volts.

Today, Van de Graaffs are to be found in nuclear research laboratories all over the world. They give a good supply of charged particles at voltages which can be maintained constant within about 0.1 per cent. But like all good things, even the constant-voltage Van de Graaff has limitations. It is limited to relatively low output energies because, in its conventional form, the voltage can be applied only once to the acceleration of the particle beam.

Tandem Electrostatic Accelerators. The idea of using linear accelerators in tandem is not new and many investigators and laboratories have developed the principles and techniques used in the new machines that have only recently appeared on the market. By means of the principle of tandem acceleration it is possible to apply the constant voltage either two, three, or four times to the accelerated ion beam, thus correspondingly increasing positive-ion output energy while retaining the precision and flexibility of constant-voltage acceleration.

In the case of the usual type of Van de Graaff, positive ions are produced inside the high-voltage terminal and then accelerated to ground in one stage of acceleration. In the case of a two-stage tandem accelerator, negative ions are produced at ground and then accelerated to a high-voltage positive terminal. Within the terminal, the swiftly moving negative ions are stripped of electrons, thus becoming positive ions, which then receive an additional acceleration from the terminal to ground. Since the particle beam receives two stages of acceleration instead of one, the device may be called a two-stage accelerator.

The principle of operation of a two-stage tandem accelerator may be seen in more detail from the diagram in Fig. 2. The positive-ion beam from the ion source at the right passes into the electron adding canal. A flow of hydrogen in this canal causes the successive attachment of two electrons to some of the positive ions, thus transforming these into negative ions. The negative-ion beam is then deflected slightly by an analyzing magnet so that negative ions of the correct mass and energy are caused to proceed along the axis of the main vacuum tubes, and thus be accelerated to the terminal which is at a high positive voltage. There the negative-ion beam passes into a second canal, where the presence of gas causes it to be stripped of its electrons, so that it emerges as a positive-ion beam and is then given its second acceleration which brings it back to ground. The positive-ion beam is then deflected through a 90 degree analyzing magnet before proceeding through a switching magnet, where it can be directed to any one of three targets.

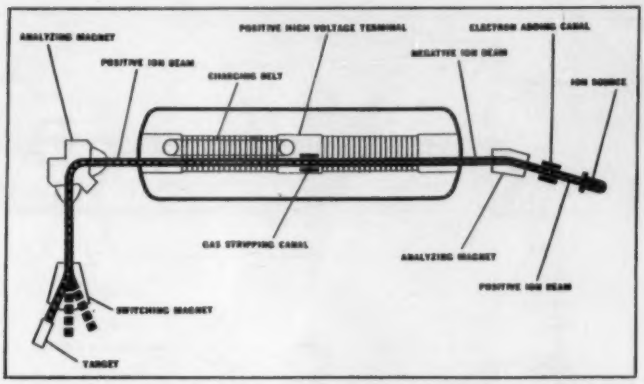

Fig. 2 Two-stage Tandem Accelerator

A two-stage tandem accelerator has been constructed by the High Voltage Engineering Corporation of Burlington, Mass., for the Chalk River Laboratory of the Atomic Energy of Canada, Limited. This machine, which is housed in a pressure tank 8 ft in diameter and 35 ft long, has recently been reassembled at Chalk River. In the tests of this unit before shipment, proton beams up to 13.4 Mev were obtained, corresponding to a terminal potential of 6.7 megavolts. After 90-deg analysis, a proton beam of 1.5 microamperes was focused on the target over a wide range of voltage. Quite recently, proton beams up to 7 microamperes have been obtained in the initial tests of a second tandem accelerator.

Possibilities For Future Development. An important feature of the tandem design is that the ion source and initial accelerating and focusing arrangements are situated outside the pressure tank, rather than inside the terminal and tank, as in the usual type of electrostatic accelerator. This external location will greatly facilitate the future development of improved ion sources and injection.

For the attainment of still higher particle energies by tandem acceler-

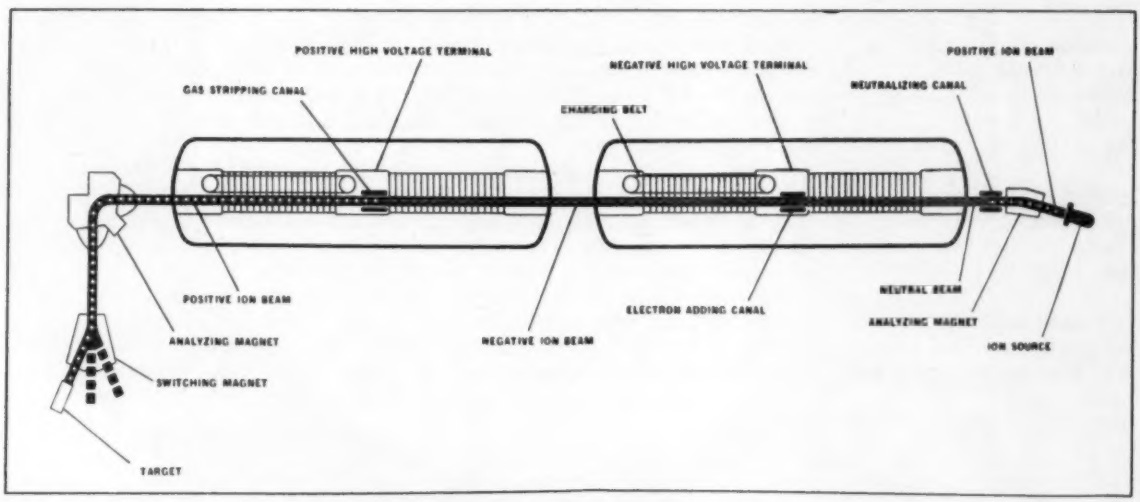

Fig. 3 Three-stage Tandem Accelerator

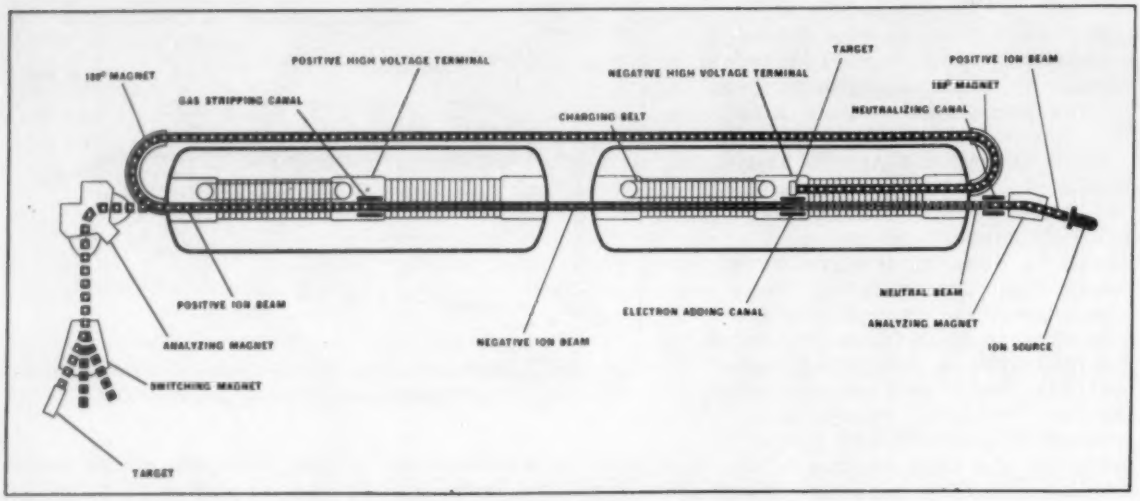

Fig. 4 Four-stage Tandem Accelerator

ation, it might be possible to use higher terminal potentials. At present the ceiling in this direction is around 10 megavolts, but it is possible that future developments will raise this ceiling. A more radical method of seeking higher tandem particle energies is by the use of more than two stages of acceleration. Figure 3 shows a diagram of a possible arrangement for a three-stage tandem accelerator. The positive-ion beam from the ion source at the right is deflected by an analyzing magnet so that the desired positive ions are directed along the axis of the acceleration tubes. In the neutralizing canal these positive ions encounter an amount of hydrogen which, though relatively small, is nevertheless sufficient to cause the attachment of a single electron to most of the positive ions, thus producing a beam of neutral particles which proceeds to the negative high-voltage terminal. In passing through the electron-adding canal situated in this terminal, some of the neutral particles capture an additional electron and become negative ions. These then receive their first main stage of acceleration in passing from the negative terminal to ground, where they are injected into the second pressure tank as a negative-ion beam of considerable energy. In this tank the beam receives its second and third stages of acceleration. The operation in this tank is quite similar to that shown in the tank in Fig. 2 except that in Fig. 3 the injected negative ions are about 100 times more energetic and correspondingly more homogeneous in energy, so that they can be focused with great accuracy through the stripping canal in the positive terminal.

It is evident that an alternative arrangement for a three-stage tandem accelerator would be to have the complete apparatus for producing the negative ions installed within the negative high-voltage terminal. However, the use of a neutral particle beam, as shown in Fig. 3, appears more promising, as it would make it possible for the particle injector to be external and at ground, a situation having enormous long-run advantages.

Figure 4 shows how a four-stage tandem accelerator could be made by the addition of two 180-deg deflecting magnets and an additional section of acceleration tube, the target being located inside the negative high-voltage terminal. This of course is a serious disadvantage since it reduces accessibility. Development of special techniques and devices no doubt could reduce the difficulties.

Consideration of these new developments in electrostatic machines make it obvious that we have come a long way since Otto von Guericke. What is more significant, however, is the fact that it took 215 years to go from von Guericke to Wimshurst, yet the interval between Robert Van de Graaff's first 1.5 megavolt machine in 1931 to the highly improved tandem units of today is a mere 28 years. We move faster these days.

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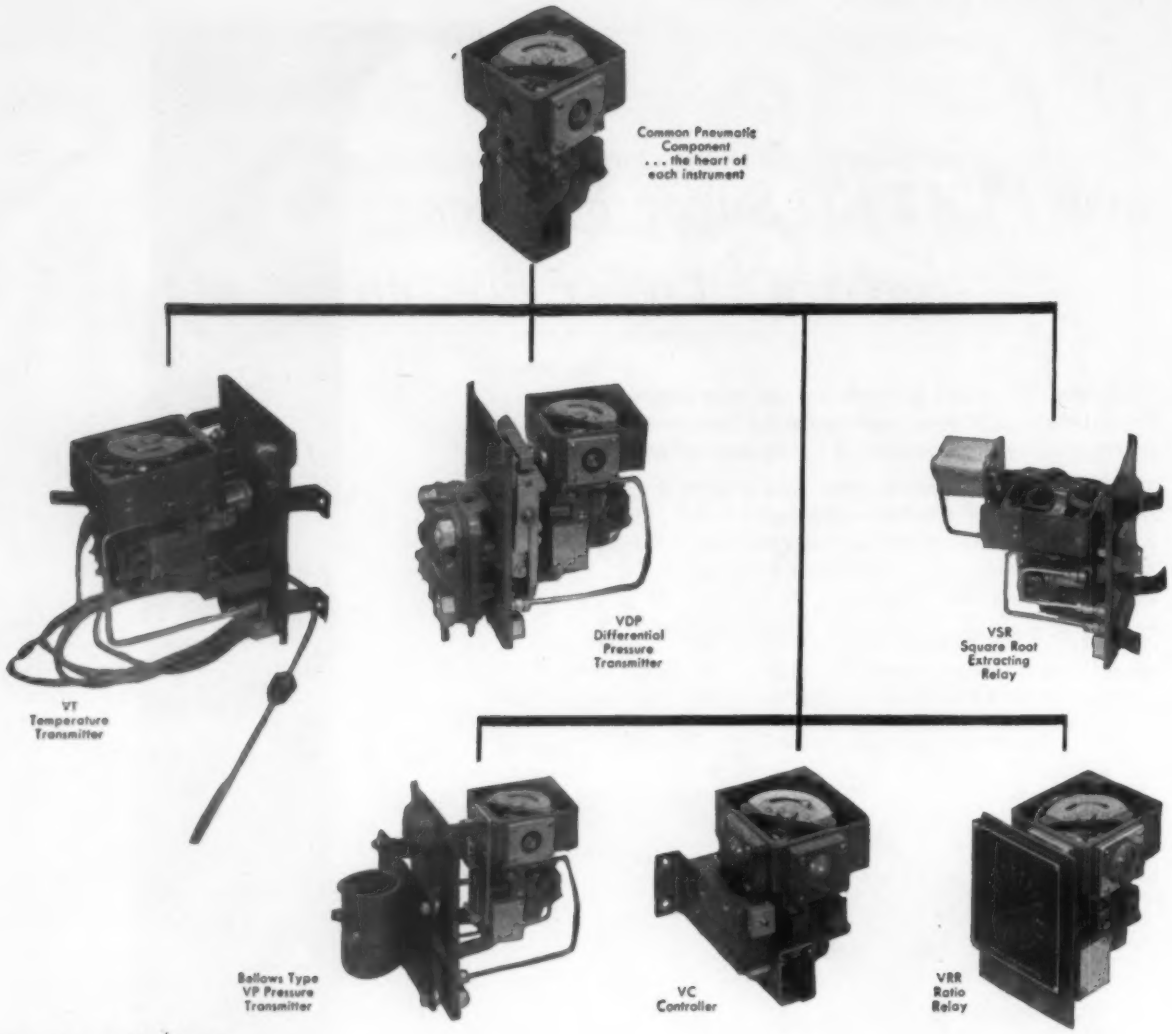
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Black Phenol, Turret Design	1279	No	Yes	Yes*	Yes	Yes	4½", 6", 8½"
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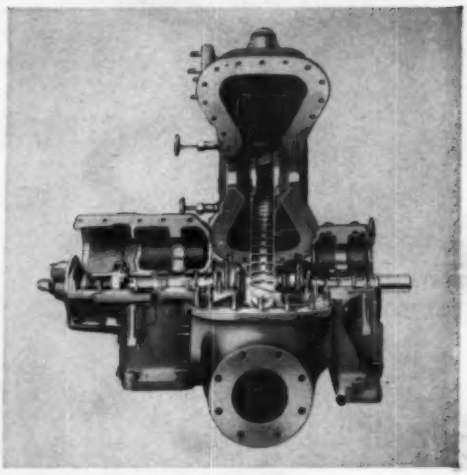

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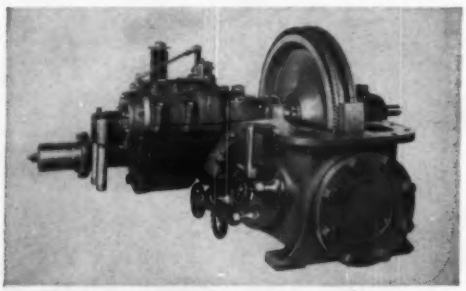
Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

TT-1209

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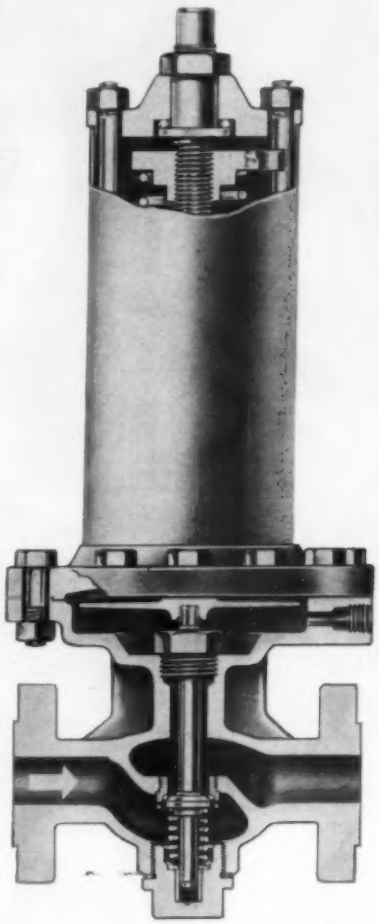
NEW LESLIE-TOPPER® VALVE DESIGNED WITH PILOTING DEVICE ENTIRELY *OUT OF THE PATH OF STEAM*

The new Leslie Topper self-contained pressure reducing valve offers a new level of accuracy, simplicity and low-maintenance service (see chart below). Key to this revolutionary valve is a piloting device which is entirely out of the path of steam. Because this mechanical pilot is sealed-off from the steam and all valve parts are designed without dirt-catching passages, the new Topper valve is ideal for both poor steam conditions and intermittent duty.

It can handle low-reduced pressures and is used in process lines, steam heat reducing stations and for make-up steam supply to heaters, gland sealing system and process equipment. You benefit from added reliability, plus the accuracy of a pilot operated valve and the rugged simplicity of direct operation. It means less shut-down time for maintenance, surer pressure control and increased plant efficiency.



SPECIFICATIONS

Sizes, Body Materials and End Connection:
½—2", cast iron, and bronze, screwed, 150 and 300 lb. bronze, flanged.
1—2" 125 and 250 lb. cast iron, flanged bodies.

Three Spring Ranges: *2-10 psi; 5-20 psi; 15-35 psi.*

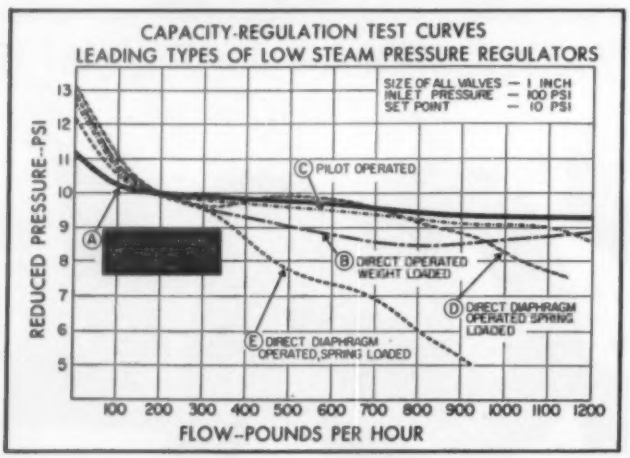
Long-travel metal diaphragm: *2 ply, phosphor bronze, Spiro-flex.®*

Main Valve: *Hardened 440C stainless steel.*

Seat Ring: *Stellited stainless steel.*

Stem Guides: *Gun metal bronze (top and bottom guided).*

Main Valve Spring: *Inconel.*



For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 582.

LC-8

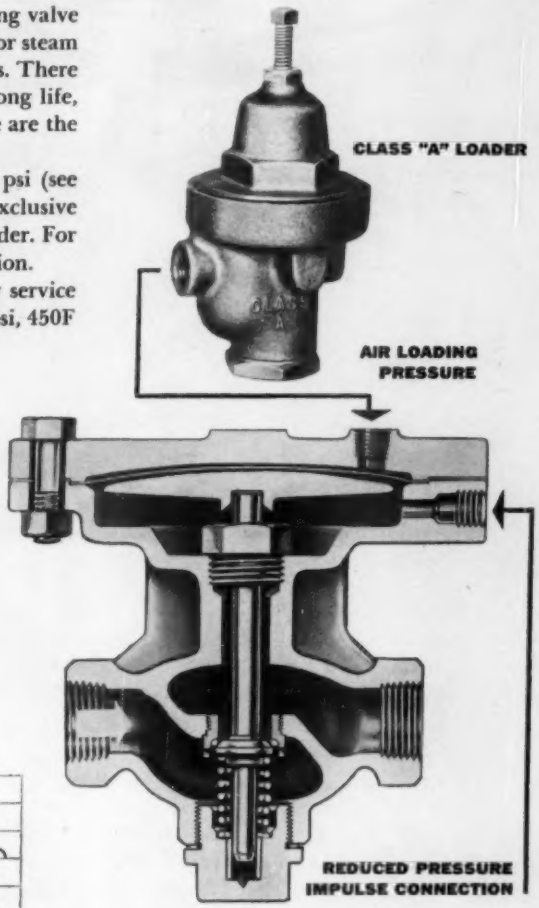
PRESSURE REDUCING VALVES

LESLIE AIR-LOADED REDUCING VALVE GUARANTEED MAINTENANCE-FREE FOR THREE FULL YEARS

New Leslie air-top GPK diaphragm operated, pressure reducing valve is guaranteed maintenance-free for three full years. Designed for steam heat or process steam application, it has only two moving parts. There are no seals, no stuffing boxes, no small dirt catching parts. Long life, long-travel diaphragm and hardened stainless steel main valve are the only parts that move.

You get accurate response even to flow changes as small as 0.1 psi (see chart below). This exceptional responsiveness results from exclusive diaphragm design and the accuracy of the simple Leslie air loader. For added flexibility, pressure can be adjusted from remote location.

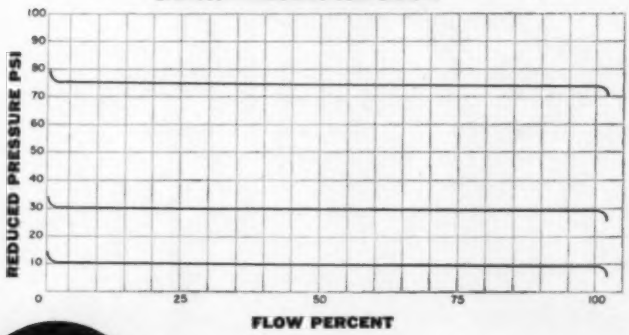
Especially desirable for poor steam conditions and standby service requirements, the GPK is suitable for steam service up to 250 psi, 450F and is available in ½" to 4" sizes.



SPECIFICATIONS

Sizes: *½ to 2", cast iron or bronze, screwed ends. 2½, 3 and 4", cast iron, 125 or 250 lb. flanged.*
Main Valve: *Hardened 440C Stainless Steel.*
Seat Ring: *Stellited Stainless Steel.*
Stem Guides: *Gun Metal Bronze (top and bottom guided).*
Main Valve Spring: *Inconel.*
Inlet Pressure Range: *0-250 psi, 450°F.*
Reduced Pressure Range: *0-85 psi with Class A loader, up to 249 ½ psi with any suitable high pressure loader.*
Minimum Pressure Drop across Valve: *½ psi.*
Available with manual opening device in sizes ½—1¼".

CAPACITY-REGULATION GRAPH



For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 561-B.

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from the . . . "HORSE and BUGGY" DAYS

• Shown at left is one of the first portable boilers. This was a horse drawn combination boiler and steam engine built in sizes from 6 to 20 horsepower and popular during the 1860's.

from the Dobbin Drawn Portable . .

• As you can see, Erie City Iron Works has been in the boiler business a long, long time. Before the turn of the century we were building portable boilers similar to the horse drawn unit above. Simple in operation and rugged in construction, this type boiler gave many years of dependable service particularly in oil field and sawmill work.

Today we build a complete line of firetube and watertube package steam generators from 1,700 lbs./hr. to the present 100,000 lbs./hr. unit shown at the right. This Keystone is a complete, modern package with burners and controls piped and wired prior to shipment. The natural circulation boiler is symmetrical in design with steel encased insulated side walls. No baffles, handholes or key caps are required on this unit. Maximum heating surface coupled with conservative ratings produce low exit temperatures and highest efficiencies.

Investigate the possibilities of renovating an antiquated, costly power plant with Erie City Keystone Steam Generators — modern as a Jet, rugged in construction and simple to operate. Write for bulletin SB-5992-E.

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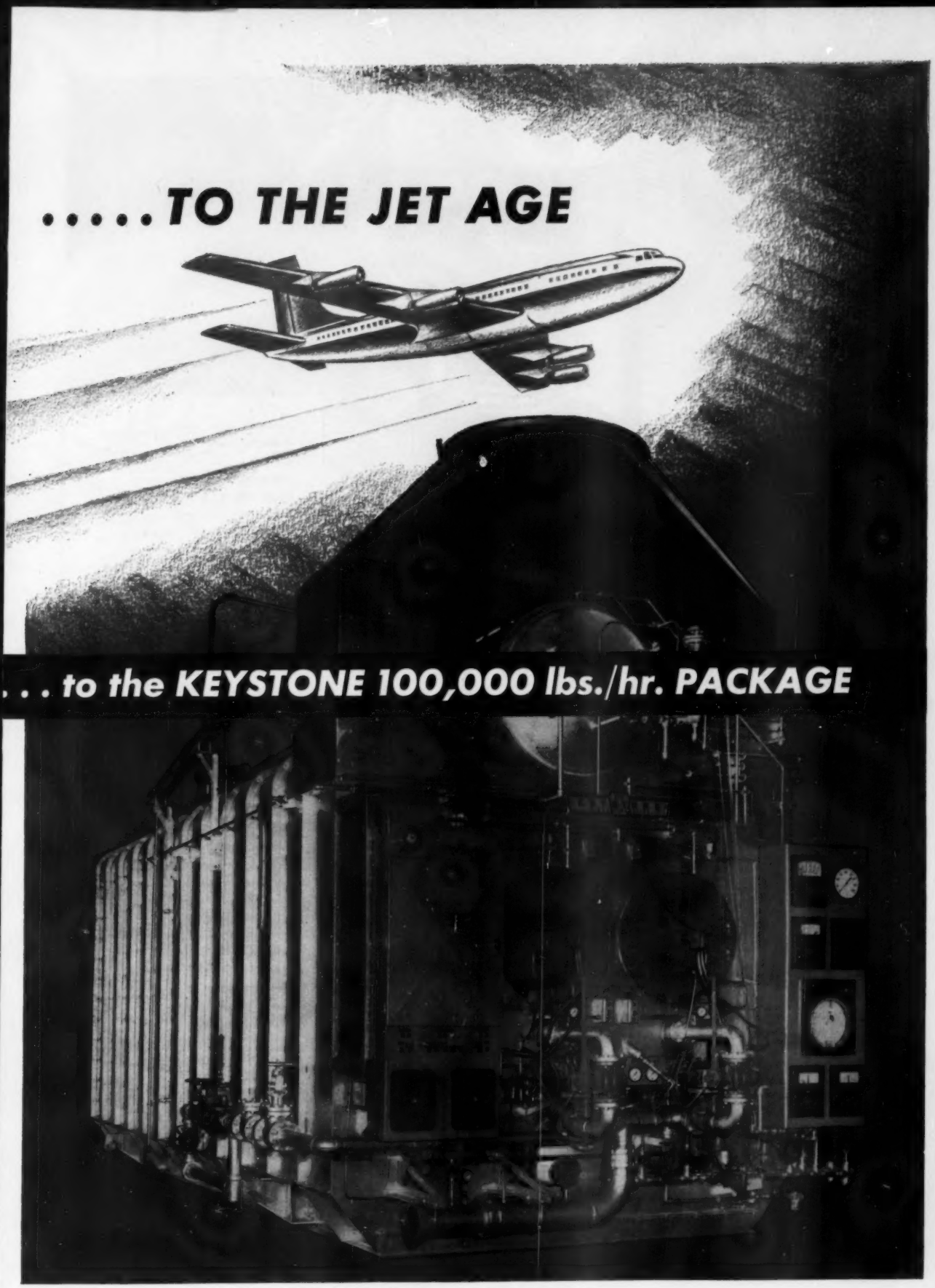
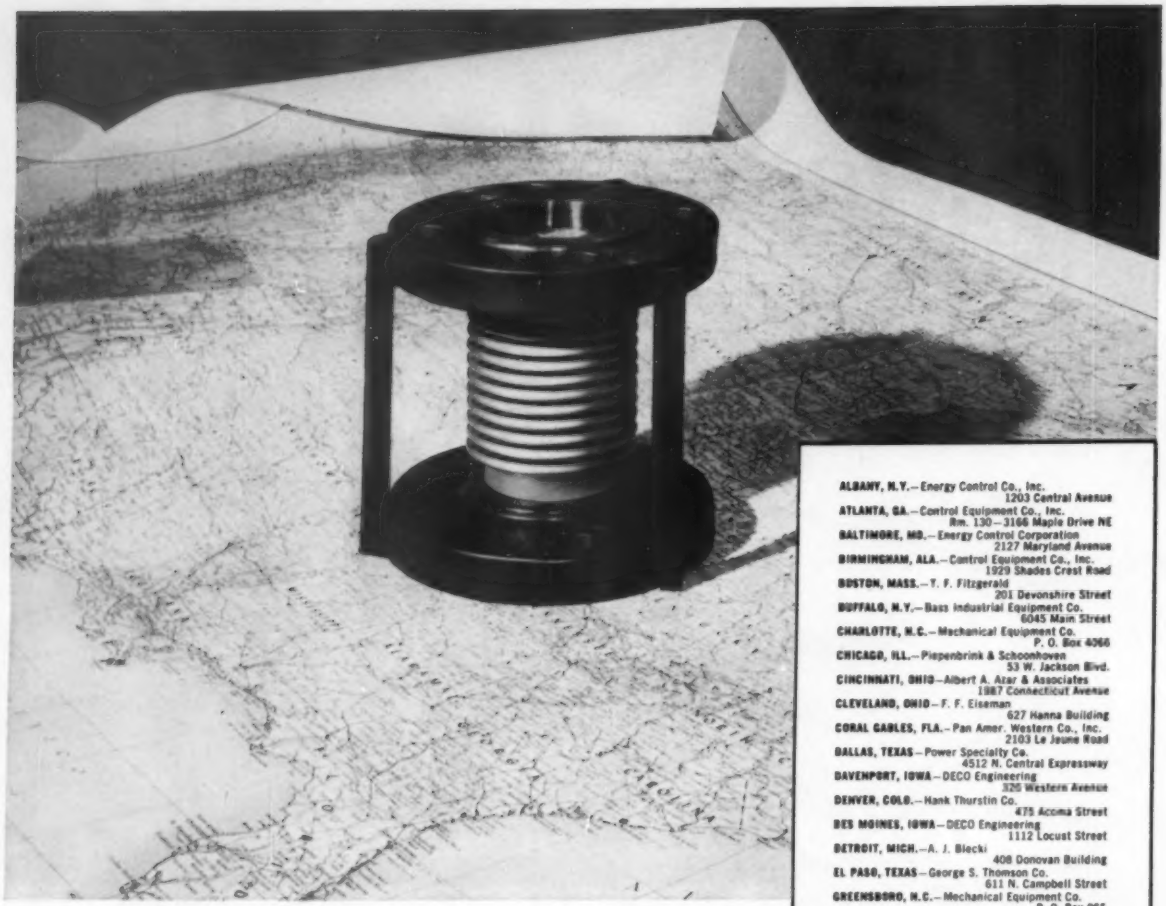

.....TO THE JET AGE
. . . to the KEYSTONE 100,000 lbs./hr. PACKAGE



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Solar manufactures the most comprehensive line of expansion joints in the world. They are made from a wide variety of stainless and high-temperature alloys in a complete range of sizes from ½ in. to 35 ft in diameter. Temperatures range from −320F to 1200F, pressures from full vacuum to 600 psi and up. *And rugged Sola-Flex expansion joints can be "in service" one to four weeks after receipt of order.*

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HAGAN NEWSLETTER
Behind the Panel

3,850,000 LB/HR BOILER (WORLD'S LARGEST) TO HAVE HAGAN CONTROLS

TVA's Widows Creek Station will have a twin furnace boiler powering a turbo-generator rated at 500,000 KW, and is expected to go in service in mid-1960. The Hagan Control package for this giant boiler includes: combustion, 3-element feedwater and air heater temperature control systems, all principal metering, panel boards and automatic data processing system. The data system, supplied by Hagan's Kybernetes division, will continuously monitor 475 variables, and log 90 of these. In addition, any group may be selected for trend logging or demand logging. Each of these special functions may be initiated without interrupting the basic scanning which monitors for off-normal conditions. Of primary interest is the fact that the Kybernetes system is capable of adding integrating and computing control functions, so that completely automatic station operation is a future possibility. (Item E-1)

PERFORMANCE GUIDES SELECTION OF SINGLE CONTROL SUPPLIER

A major gas turbine manufacturer chose several manufacturers to supply control components, among them Hagan. As operating experience accumulated, it became evident that the Hagan components were superior in terms of reliability and accuracy. More and more Hagan components were specified, until today, the whole control package on every turbine is made up of Hagan equipment. Included are shockproof ratio totalizers, gas turbine thermostats, hydraulic toggle valves, sequential totalizers, and other Hagan components specifically engineered for the type of rugged service encountered by both stationary and mobile gas turbines. (Item E-2)

ALLOYS DEMAND PRECISE TEMPERATURE CONTROL DURING SOAKING

Soaking pits which are used for the heating of alloy steels must have a precision temperature control. The billets must be brought up to an exact temperature at a controlled rate; any over- or under-shooting of the desired temperature will have an adverse effect on the characteristics of the alloy. That is why Hagan fuel-air ratio, pit temperature and recuperator temperature controls were installed on a series of six new pits recently built by a major steel producer. The pits have been in service for nearly a year, heating alloy steels primarily, and operators are pleased with the performance of the Hagan controls. Required temperatures are reached at the proper rate, there is absolutely no over-shoot, and maintenance of the control equipment has been merely routine. (Item E-3)

WHEN "START-UP TIME" IS AN IMPORTANT FACTOR

Getting an installation going after construction is complete usually depends on how fast the control system can be put into operation. And that in turn usually depends on the skill and experience of the field engineer in charge. At a recent Hagan installation involving complete combustion control systems for twelve open hearth furnaces, sixty days of service time was included in the contract. The twelve furnaces are in excellent operation, and the total service time used amounted to only fifteen days. There are two reasons for this: one is that the Hagan field service engineer knew exactly what he was doing, and the second is the elegant simplicity of Hagan control components and the fact that they are shop calibrated and ready to go to work as soon as installed. This allows operating personnel to become familiar with the simple adjustments quickly and easily. At another installation which included combustion control, feed water control and principal metering on three large boilers, the superintendent stated that the thing he liked best about the systems was the ease with which they went into operation, and the excellent services rendered by the Hagan field engineer in charge. (Item E-4)

KYBERNETES DATA LOGGING SYSTEM FOR REFINERY

Scanning and providing visual readout of 100 temperature points in a catalytic reformer, this data system, designed and built by Hagan's Kybernetes division, can be expanded to accommodate readout of flow and pressure data. Installed to provide operating experience with data loggers in refinery operation, the system is seen as being the first step in the use of complete computer control. (Item E-5)

HAGAN CHEMICALS & CONTROLS, INC.

Hagan Building, Room 704, Pittsburgh 30, Pennsylvania
In Canada: Hagan Corporation (Canada) Limited, Toronto
European Division: Via Flumendosa No. 13, Milano, Italy

If you would like more information on any of the above items, check the appropriate box below.

☐ Item E-1 ☐ Item E-2 ☐ Item E-3 ☐ Item E-4 ☐ Item E-5

For more data circle 541 on Post Card

NEWS FROM YARWAY

now!

A NEW YARWAY COLOR-PORT GAGE FOR MEDIUM PRESSURE BOILERS

The Yarway Color-Port Water Level Gage, so outstandingly successful on high pressure boilers, is now available in a new model designed especially for boilers operating up to *1050 PSI.*

Yarway Color-Port gives you all these *triple advantages:*

- *Two color readings,* brilliant and clear. Water shows green; steam shows red. A full gage is all green; an empty gage all red.
- *Low maintenance.* Servicing the Color-Port is simple as A-B-C. With gage remaining in place, individual cover plate assemblies can be inserted in a matter of minutes. Exclusive spring loading maintains proper pressure on glasses and gaskets at all times.
- *Increased operational time.* Yarway Color-Port Gages assure longer operational life, with a minimum of "time out" for maintenance.

Replace troublesome water level gages with the new medium pressure Yarway Color-Port—and for your new boilers, make sure the specifications read YARWAY COLOR-PORT. Visibility ranges of *13"*, *15½"* and *18"* available.

Free descriptive Bulletin WG-1815 on request.

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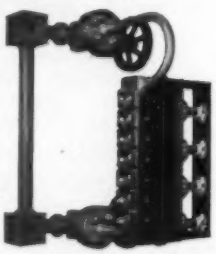

Complete Color-Port assembly, with tie-bar column, Welbond Gage Valves and Yarway Illuminator.

Complete cover plate assemblies can be replaced in minutes, with the gage in place.

YARWAY

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TRACERS

Power Engineering's Monthly Probe of Power Facts

At Gillette Safety Razor, efforts to conserve and utilize the maximum possible amount of heat energy of the fuel purchased have resulted in electricity generated at a cost of less than five mills. So complete have been their conservation measures that even should the value of the electricity generated be disregarded entirely, steam from the diesel-engine waste-heat boiler would be cheaper than that from an hrt boiler! This startling system is described by E. E. Kimball, on pages 86-88.

Gas turbine engines may be made economical for use in automobiles by the addition of a device called a "rotary regenerator." General Motors' Technical Center reports that a regenerator cuts the amount of fuel required, by putting to work heat that would otherwise be wasted in exhaust gas. A regenerator is being built into GM's experimental automotive turbine engine, Whirlfire.

Is the U. S. making a serious mistake by not pushing work on underground gasification of coal as a fuel resource? In other countries, Russia especially, interest in the process is producing impressive results. See the review of this little-noticed situation, pages 66-68 of this issue.

First fully-automated electrical power generating station will be a 225,000-kw facility to be built at Little Gypsy, La, for Louisiana Power and Light Co. All phases of Little Gypsy's operation, from start-up through operation to shut-down, will be controlled automatically by an electronic computer system designed and built by Daystrom. For details, see the article on page 69.

Atomic blasting to open up oil fields is one of the latest prospective uses for nuclear power. AEC is reported to be experimenting with the idea on a mesa in Colorado, while California's Richfield Oil Corp has asked permission of the Canadian government to set off a nuclear charge to free oil under the Athabaska sands in northern Alberta and Saskatchewan. If the Canadian venture works, 330 billion bbl of crude oil are expected to be freed in that area alone.

Growth of iron oxide in areas of high heat transfer is a "disease" that afflicts tubes in boilers operating at high temperatures. As Douglas E. Noll explains in his article on page 91, cure is not necessarily simply a matter of modifying boiler water chemistry. Acid cleaning of the boiler at the right time is part of the prescription.

A flat "light bulb" which has no filaments, produces practically no heat, which is glare-free and will burn night and day for a year for less than a penny, has been introduced by Westinghouse for home use. The new bulb is an electroluminescent cell, consisting of a phosphor coated on a glass panel which has been treated to conduct electricity. When power is applied, the panel lights. Rated at 1/200 of a watt, it's intended for any location where low level brightness is desired.

UNDERGROUND GASIFICATION...

Is U.S. Second Best?

TO A NATION grown accustomed to a Federal budget designed to maintain American supremacy in all matters pertaining to national security, and geared directly to Iron Curtain activity, it will probably come as a distinct shock to learn that we are behind the Russians in yet another field of endeavor. Not only are we behind in one critical field of fuels technology; we can hardly lay claim even to a respectable start in underground gasification of coal. Both the Russians and British are well ahead of this country in this work.

Underground gasification of coal has been studied in varying forms since before the turn of the century. Gasification of slack and waste coal in the mine was suggested in 1868. In 1909 an American, A. O. Betts, obtained a British patent covering a method of gasifying coal. In Russia, Lenin fostered research in 1917, but preliminary experiments were not started there until 1930.

Today Russia, France, Britain and, to a much lesser degree the United States, are all active in developing processes for extracting gas directly from coal beds situated far below the earth's surface.

Essentially, underground gasification of coal involves sinking a passage into the coal bed and connecting it to the surface by inlet and outlet pipes. The coal bed is then ignited and air, oxygen, or steam injected into the underground retort or reaction chamber. Gases thus manufactured are collected at the surface outlets.

British Coal Board has recently completed and placed in operation a 5000-kw generating station near Sheffield that operates on gasified coal. Coal seam being gasified is of secondary quality, not worth mining due to its high ash content. (See POWER ENGINEERING for July, 1957.) Based on results thus far obtained from this pilot plant operation, a full-scale station of 60,000 kw is now being designed for the process. A spokesman for the British Authority stated, "There are hundreds of millions tons of coal in Britain that are unminable by ordinary means, but which may be exploited by the underground gasification process."

In Great Britain, over 50 field trials on two sites, and involving six different seams of coal, were conducted over a seven-year period. Non-coking and medium-coking coals were among those tested, with no great difference being noted in their gasifying performance. In one of the later experiments approximately 1700 tons of coal were gasified over a four-month period. Gas obtained averaged just under 100 Btu per cu ft at a cost of from three-fourths of one cent to two cents per therm. This compares to cost of coal at pitheads in Great Britain of approximately three cents per therm, and imported fuel at seven cents. Experiments are underway at the moment aimed both at raising Btu content of the gas and lowering costs per therm.

Russian Results Are Impressive

Russians' output of fuel gas generated from coal processed in the vein without mining now runs into billions of cubic meters annually, according to a comprehensive review of underground coal gasification in USSR published in *Ugol* (Coal), leading Soviet coal mining journal. With this coal-source gas, Russia has embarked on what is termed the first group of industrial plants based on this process. Projects include a large gas-burning electric generating station in

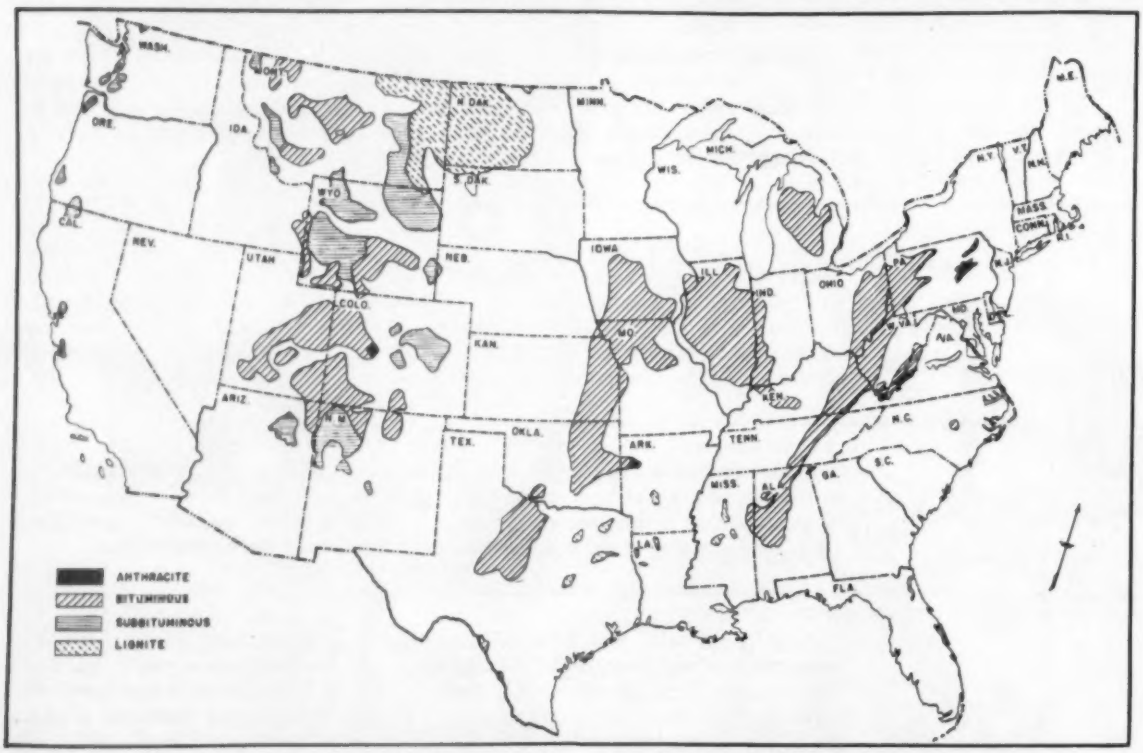


Fig. 1. This map shows tremendous lignite deposits in U. S. that are available profitably to underground gasification process

Let's Keep Research Dollars in Proper Perspective

Editorial Comment

Russia has already "declared war" on the United States in the field of industrial development and world trade. In such a struggle, fuel resources and their economics could quite easily tip the balance against us.

Considerable confusion beclouds the future fuels picture in the United States. This confusion stems from conflicting statements from opposing camps. Advocates of power from exotic sources contend that the supply of fossil fuel is rapidly dwindling and urge conservation of our remaining coal reserves for the manufacture of steel and vitally essential coal-tar derivatives. Research organizations within the coal industry, however, deride this viewpoint. They are equally emphatic in contending that proved resources are adequate for the next several generations; they document their position well.

If the first concept is correct, then certainly we cannot long neglect development of the extensive lignite and sub-bituminous deposits in this country in order to preserve our remaining sources of anthracite and bituminous coal for purposes other than power generation. If the latter thesis is true, then economic gasification methods for reclaiming marginal deposits would add tremendously to our proved coal resources. They would also go a long way toward eliminating confusion as to sources of tomorrow's energy.

Alongside the millions of dollars being poured into missile development, to say nothing of nuclear energy and hydro projects, the $200,000 allocated in the past to the Gorgas project described in this article, seems woefully inadequate. Compared to the 400 engineers Russia reports assigned to underground gasification' the 15-man task force at Gorgas, all the budget will support, borders on the pathetic.

We do not count ourselves among these groups hysterically demanding that we engage in an all-out race with Russia on any and all scientific developmental fronts. We would merely point out that if development of atomic energy is so vital to our future (and it is), and if there is a legitimate need for further expenditure on large dams for power generation, then vigorous prosecution of a research and development program for underground gasification of our vast lignite deposits is of the same high degree of importance.

Ironically enough, a large portion of our proved lignite deposits are in the same area that would be served by a proposed Federally-financed hydroelectric development. Those in position to know tell us that a very minor fraction of the cost of this dam could adequately finance necessary research and place this deposit into economic operation at an overall cost of less than a quarter of the cost of the dam.

We believe that a wise course of action would be for the Congress to establish this Gorgas project under the Department of the Interior in a separate Bureau similar to the U. S. Coast and Geodetic Survey or the Bureau of Reclamation, with an adequate budget. Two million dollars, expended annually, has been stated as an adequate figure. We strongly urge electric utility and industrial bodies and all persons interested in conservation of our natural resources who feel as we do, to communicate this feeling to their elected representatives promptly and forcefully.

the Angren coal basin of Central Asia and a gas-fired steel mill in the Kuznetsk coal basin of Western Siberia. According to the Soviet journal, Russian engineers now consider underground gasification to be a more economical method of developing coal-energy resources than is conventional mining. They claim that in gas combustion, heat is better utilized and costs are infinitely lower than in coal combustion. Preliminary loosening of the coal strata is no longer a feature of the Russian process, which is now in operation without human labor underground.

Process developed by the Russians reportedly results in a gas having 133 Btu per cu ft, substantially higher than results obtained by the British. If this figure appears inordinately low, it should be remembered that every major steel mill uses electric energy generated from blast-furnace gas having a Btu content of from 90 to 110 Btu per cu ft.

The large new Shatskaya generating station just completed in the Moscow coal basin is described by *Ugol* as being fueled entirely by gasified coal. This is a gas turbine plant in which the gas flows directly from the underground retort to the gas turbine units. At rated capacity, the station will utilize 74 million cu ft of 133 Btu-per-cu-ft gas daily. This is reportedly the equivalent of 226,000 tons of mined coal annually.

In the Tashkent region of Central Asia, an underground-coal gasification station is going up in the Angren brown coal basin that will have a rated capacity of 50 million cu ft of 130 Btu gas daily. This will fuel a steam-turbine electric station of 100,000 kw. First section of the Angren station went into operation late in 1958.

These two stations appear to be the first of a large-scale program. *Podzemgas*, USSR central agency for this section of the fuel industry, has announced initiation of the following projects:

1. Stalinsk station at the Bungure-Listvenskiy coal field in the Kuzbass will have an annual capacity of 280 billion cu ft of gas estimated to contain 138 Btu per cu ft. Gas generated here will also be used in the Kuznetsk steel mills. *Podzemgas* estimates that when gasified coal replaces solid fuel at the Kuznetsk steel mill's thermoelectric station and agglomeration plant, net cost of fuel delivered to the furnaces and boilers will be reduced from 67.5 to 37.7 rubles per ton of conditioned fuel.
2. Stalinsk No. 2 station will likewise be built in this same region, and will also have an annual capacity of 280 million cu ft of gas. This supply will fuel the existing Stalinsk thermoelectric station which has a rated capacity of 241,000 kw. *Podzemgas* states that the gas generated will fully meet the station's fuel requirements.
3. At Stalinogorsk, a gasification station having an annual capacity of 125 billion cu ft of gas will be built to exploit the brown coal deposits of the Moscow coal basin. Gas production here will be allocated to a thermoelectric generating station of 100,000 kw.

Podzemgas has a special planning and research bureau staffed by 400 engineering specialists in the field of underground coal gasification, according to its latest report. "The design of gas generators at the Lisichansk and Yuzhno-Abinsk stations has been greatly improved. As a consequence, losses of coal have been greatly reduced and the Btu content of the gas boosted," the report concludes.

American Program Lags

American efforts have, with minor exceptions, been largely confined to joint activities of the Bureau of Mines and Alabama Power Co at the power company's mines at Gorgas,

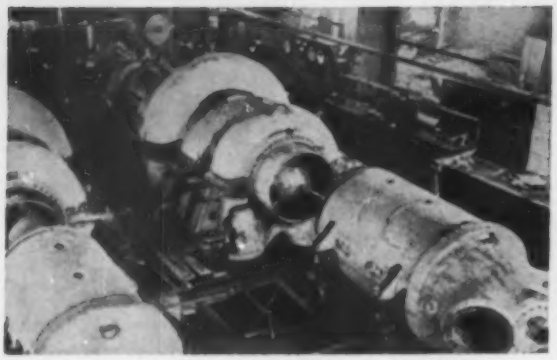


Fig. 2. Turbine hall at Shatsk underground gasification plant during assembly. Two units will deliver 16,000 kw for USSR

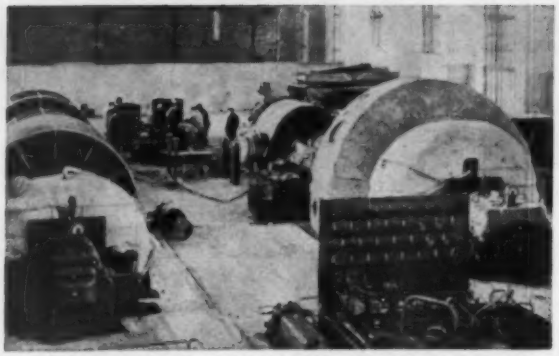


Fig. 3. These 4000 kw turbines, shown here during construction, will be fueled by gas from Stavropol-Moscow gas main

Ala. (See POWER ENGINEERING for May, 1950.) Alternately blessed and damned budgetarily, this work has been in progress on an intermittent basis since 1946, entirely under supervision of Bureau of Mines engineers.

Like both Russian and British efforts, American experimentation largely has been devoted to drilling holes from the surface and fracturing the coal beds by passing electric current through them to make a path. After the path for the gases has been established, coal beds are ignited and gasification proceeds.

One of the later experiments at Gorgas was successful in gasifying coal over a long period of time and resulted in a reasonably satisfactory gas. In time, however, the gas would deteriorate in quality. Same experience had been encountered after periods of time, both in fracturing the coal beds through pressure and by connecting holes with use of electric current. They were, however, successful in making gas of usable Btu for periods of six weeks to three months. It is the contention of Milton H. Fies, Vice President for Coal Operations of Alabama Power Co, that this can ultimately be extended to three to thirty years.

In the early Fifties, after a Federal economy drive, the Bureau of Mines discontinued the experiment. For several months the work was continued by Alabama Power in hope the position would change. Then, in 1956, the Department of Interior and Bureau of Mines again became interested and approximately $200,000 annually was earmarked for the project, with roughly $170,000 of this amount available for work at the mine.

Most of the experimentation at Gorgas has been conducted using air as a gas-making fluid. Btu value of the product gas when using air was about 100 Btu per cut ft. Gasification with oxygen and with steam was tried for limited periods during recent experimentation. Oxygen produces a gas having a heating value of about 200 Btu per cu ft. Gasification operation was continuous when either air or oxygen was used. In order to gasify with steam, a cyclic process was used wherein heat was stored within the fuel bed during an air-run period and product gases evolved during a steam run. These steam-run gases had a relatively high heating value of about 300 Btu per cu ft. These data were reported in a paper, "Energy and Economic Evaluation of the Parameters of Several Underground Gasification Processes" by Pears, Capp, and Fies. The paper concludes that a continuous process might be developed using oxygen and steam as the fluid streams.

Current Efforts at Stand-Still

Of particular interest is the fact that lignite has been shown to be more reactive to the underground gasification process than bituminous coal. Most lignites run from 25 to 35 per cent moisture. It is this moisture that might exert influence in the enrichment of gas just as steam does in the manufacture of water gas.

Available for exploitation by the underground gasification process in the United States are 463.5 billion short tons of lignite and 373.8 billion short tons of sub-bituminous coals, according to latest figures published in Bituminous Coal Facts, a Bituminous Coal Institute publication. It is worth noting that the bulk of these deposits are located in the Northwestern United States, where an increased demand for power expansion has been manifest in recent years.

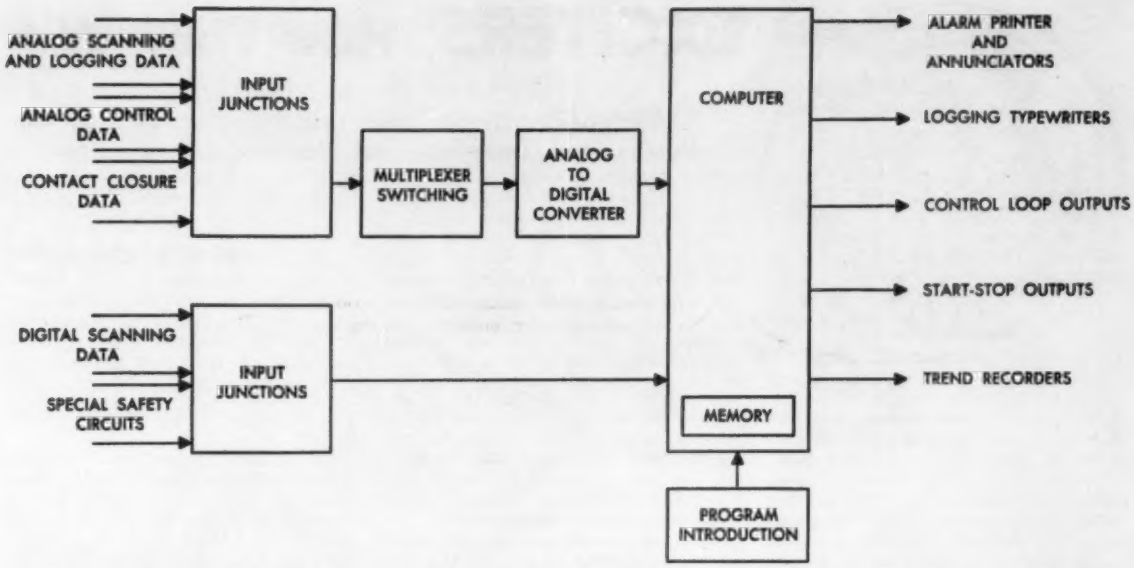
Actual experimentation at Gorgas is currently at a virtual stand-still due to budget deficiency. In order to experiment with oxygen, which is relatively expensive, the Bureau of Mines has assigned all remaining funds for the fiscal year to an oxygen experiment. Until additional funds are appropriated in July, assuming they will be, the work at Gorgas will be confined to making reports on what has transpired within the last year, and in maintaining the facility in a standby condition.

Position of the Bureau of Mines appears to have crystallized around the philosophy that, because we now have other forms of fuel which can be produced at a lower cost, the matter of underground gasification of coal is something for the distant future. For this reason, there is a feeling that the work in progress may either be abandoned entirely, or it may be continued on a piece-meal basis until such a time as urgent necessity may force public attention on the project. In an era when millions after untold millions are being poured into research aimed at using more exotic sources of energy, only time can testify as to the wisdom of this policy, or the lack thereof. THE END

REPRINTS OF VALVE MANUAL

A series of articles on basic valves used in the power field has been running in POWER ENGINEERING for the past several months. This series has now been completed and we have prepared a complete reprint called the Power Engineers' Valve Manual. Since this series of articles was written by recognized experts, we feel this is one of the most authoritative treatises on valves yet to appear.

Single copies of the Valve Manual are available to our readers free of charge UNTIL MAY 30. Simply write us on your letterhead requesting a copy. Those of you who have already requested copies need not write again; your requests will be filled automatically. Quantity prices are available at minimum cost.



Simplified diagram of the computer-control system for Little Gypsy station of Louisiana Power now under construction

Louisiana Power Builds World's First Fully Automatic Thermal Station

FIRST FULLY AUTOMATED thermal generating station in the world will go into operation early in 1961 near the town of Little Gypsy, La.

This 225,000-kw facility of Louisiana Power & Light Co will operate with steam conditions of 2000 psi and 1000 F, with reheat to 1000 F. Natural gas will be the initial fuel, with provisions being made to utilize solid fuel at a later date if such should prove desirable. Boiler will be provided by Riley Stoker Corp; General Electric Co will build the turbine-generator.

Site is approximately 25 miles upstream of New Orleans on the Mississippi river. It will have more than one-half mile of frontage on the river, and will include a total of 330 acres. Initial installation is one-tenth of the planned ultimate development of two million kw at this site.

All phases of Little Gypsy's operation, from start-up through operation to shut-down, will be controlled automatically by a special electronic computer system designed and built by Daystrom, Inc.

Construction of the Little Gypsy station started in October of last year. When completed in January, 1961, the station will be manned by a normal complement of operating personnel.

Rather than a potential reduction in personnel, the real advantage of the control system results from its faster reaction and greater sensitivity. Because of this, the station can be operated much closer to actual equipment operating limits for highest overall efficiency, and with unprecedented safety.

Control system for Little Gypsy benefits from experience gained at Louisiana Power & Light's Sterlington station, where a Daystrom solid-state operational information system, containing approximately 4000 transistors and 7000 diodes, has been in successful operation without component failure for nearly a year.

Dispatch Control Is Automatic

Approximately 800 steps must be conditionally and sequentially controlled in starting up a large generating unit. Roughly, 700 points of inspection and actuation are involved.

After each step the computer will scan, at lightning speed, 700 different temperatures, pressures, flow rates, and valve and switch positions. If all is in order, an electrical command will go out to hundreds of valves and switches to change to the next position.

Information presented to the computer for evaluation will be in the form of electrical energy at signal levels less than one-tenth the strength of human brain waves. If, under any circumstances, the computer should find itself confused, it will resign automatically and turn the plant over to the human operators, in semi-automatic operation, with appropriate visual and audible signals.

Programs for hot and cold start-up, for complete shut-down, and for temporary shut-down and banking the boiler will be provided as automatic functions of the system. During start-up it will be possible for the operating personnel to "instruct" the computer to turn back or skip ahead to any operational stop in the start-up procedure.

When the computer puts the station on the line, it automatically re-programs itself and goes into operational mode, operating all major control loops.

Computer will be in continual contact with the main dispatch center of Louisiana Power & Light Co in Pine Bluff, Ark. Dispatcher will tell the computer directly to increase or decrease station output. Within one second of a command, proper action will be taken simultaneously in all operating loops.

Computer will constantly monitor phase of the system and the generating unit. Should malfunction occur and the generator get out of phase, the computer immediately removes it from the line.

System will be programmed to print out proper station log sheets once each hour on the hour. Provisions will also exist to print out log data with each complete scan cycle, or any multiple thereof, at the discretion of operating personnel.

Louisiana Power & Light Co has grown from an installed-capability of 145,000 kw in 1945 to a present installed-capability, without Little Gypsy, of 692,000 kw. It is altogether fitting that the system should approach million kw capability with the world's first completely automatic thermal electric station. THE END

EXCITERS: How They Work

Author reviews function and application of exciters, their abilities and limitations, and describes recent innovations

By G. L. OSCARSON*

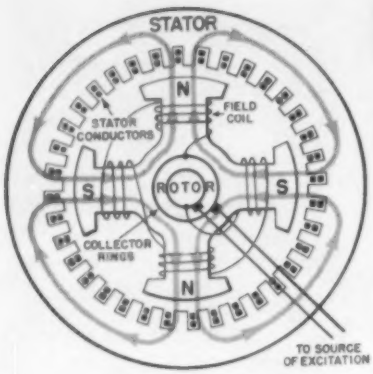


Fig. 1. Magnetic flux paths in a four-pole synchronous motor, produced when the exciter energizes the field coils

ELECTRIC MOTORS like all other electro-magnetic devices must be "excited," or, to use a more common term, magnetized. In the case of the induction motor a magnetizing component of the total current from the line serves this purpose.

Excitation for synchronous motors and generators is supplied from a separate source of direct current generally provided by a d-c generator. This direct current flows through the field winding of the motor or generator producing a magnetic flux that links the stator coils as shown in Fig. 1.

If the conductors in the stator are properly connected and the rotor is revolved, the lines of magnetic flux will cut the conductors and generate a voltage.

The mathematical expression for the voltage generated is:

$E = 4.44\ n\ f\ \phi\ 10^{-8}$

where: E = root-mean-square volts (RMS)

n = number of turns in stator coil

f = cycles per second

ϕ = total lines of force

Before the iron in the motor begins to saturate, an increase in exciting current produces a proportional increase in magnetic flux, and hence the voltage, by the above expression, is increased a proportional amount. As the iron becomes saturated the generated voltage per unit of added exciting current decreases.

Now let us consider a synchronous motor connected to an a-c bus fed from an a-c generator. Also assume there is no load on the motor and that there are no losses. If properly synchronized the motor will operate at synchronous speed but will draw no energy from the generator.

To meet this condition we can assume that at a given instant the vector OG in Fig. 3(A) represents the voltage delivered by the generator. To meet the condition of no flow of energy to the motor, an equal and opposite voltage must be generated by the motor. This is called the counter-electromotive force and is represented by the vector OM.

After a short interval of time the generator rotor has turned counter-clockwise about 20 degrees so that its voltage vector, unchanged in magnitude, is now at the position OG_1 in Fig. 3(B). During this interval of time a load is applied to the motor, momentarily slowing down the rotor. Its vector is now represented by OM_1.

By combining voltages OG_1 and OM_1 a small resultant voltage OR_1 is obtained and this, divided by the impedance of the circuit, equals the current OI_1. Upon reaching a steady state condition this current takes care of the motor losses and load.

The rotor lags by an angle α_1 behind the previous no-load condition. The high inductive impedance in the circuit causes I_1 to lag OR_1 by nearly 90°. It thus lags the line voltage by a small amount and the power factor is lagging. The "in-phase" component of the current is shown by OC.

Effect of Increasing Excitation

By increasing the excitation to the synchronous motor the counter-electromotive force will be increased to a value OM_2, Fig. 3(C). The angle of lag will be decreased slightly to α_2 on account of the stronger magnetic pull. The resultant voltage OR_2 will cause current OI_2 to flow. The current is now directly in line with the supply voltage and unity power factor is the result.

A further increase in excitation, other conditions being unchanged, would result in a further decrease in the angle of lag and increase in motor counter-electromotive force. This is shown by α_3 and OM_3 in Fig. 3(D). The resultant voltage OR_3 is now in such a position that the current OI_3 it causes to flow will greatly lead the line voltage.

The power factor is now 0.8 leading. Note that at 0.8 leading power factor the counter-electromotive force and hence the excitation is about 30 per cent greater than at unity power factor.

A synchronous motor, designed and built for that purpose can thus be made to operate at unity power factor or at various values of leading power factor.

Excitation Voltages

NEMA standards for industrial synchronous motors provide for 125 or 250 volts excitation. 250-volt excitation is not commonly used, nor is

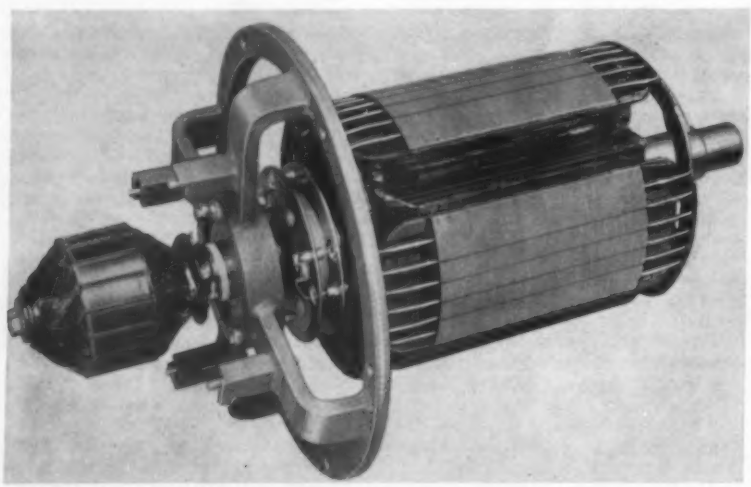


Fig. 2. Brushless exciter assembly, showing exciter armature, rectifiers mounted on discs, and generator rotor. Commutator, slip rings and brushes are eliminated

*Chief Application Engineer, Electric Machinery Manufacturing Co

with Synchronous Motors and Generators

it desirable on small high-speed motors because of the low value of excitation current and corresponding small wire sizes. Collector ring voltage is usually about 110 and 220 volts respectively for the above excitation voltages.

Types of Exciters

There are two main types of exciters in the field today, which may be classed as rotating and non-rotating. The latter is a relative new-comer to this field of excitation.

Non-rotating: There are several types of non-rotating exciters; however, they all use the same basic principle. They change an a-c voltage to d-c by using some dry-type rectifier. Control of the direct current may be obtained by having a saturable-core reactor in the a-c circuit.

Rotating: *Direct-connected exciters* are generally used with motors above 500 rpm. This type exciter has no shaft or bearings of its own. The armature is mounted on the motor shaft extension, the field ring being supported from the motor bearing bracket or pedestal. In the case of vertical synchronous motors, direct-connected exciters are frequently used for speeds as low as 200 rpm.

Exciters are basically a-c generators in which the current is converted to d-c by the commutator. A recent development so far used with synchronous generators but not with synchronous motors is the brushless rotating exciter. In this construction the commutator is replaced by rotating rectifiers mounted on discs on the generator shaft; these rectifiers connect the exciter armature to the generator fields without use of commutators, slip rings or brushes. A typical arrangement is shown.

Air compressors driven by shaft-mounted engine-type synchronous motors frequently have large flywheels to limit the current pulsation. *Belted-type exciters* can then be conveniently used, driven from the compressor flywheel.

Refrigerating compressors more commonly have all of the flywheel effect incorporated in the motor rotor. Since there is usually no convenient place for belt drive, individual *induction motor-generator* sets are generally used. The synchronous motor controls can be arranged so only one push-button station is needed.

Where ambient conditions near the motors are unfavorable for d-c generator operation due to presence of carbon black or dust, large motor-generator sets, frequently synchronous motor-driven, installed in a clean location are used. The d-c generators are then compound wound, and if operated in parallel, must have equalizer connections to insure proper division of load current. If exciter sets are operated in parallel, a reverse-current relay or overspeed switch must be used. This is necessary because in case the a-c driving motor of one unit fails, its associated generator may motor and run away, causing damage due to overspeed.

Excitation obtained from a common source for many motors is known as *bus excitation*. Some means of excitation adjustment to individual synchronous motors must then be provided. Series rheostats are commonly used, but unless frequent adjustment is required fixed resistors are preferred. One exception would be where several identical motors are operated off one set. In such case, adjustment of the generated d-c voltage by means of a shunt-field rheostat will suffice.

Operation of Exciters

Individual exciters are always straight shunt wound. The excitation voltage is adjusted to obtain rated nameplate motor excitation at full load hot. Shunt wound exciters may be operated in parallel if their regulation is sufficiently uniform.

Compound-wound exciters will also have their no-load voltage adjusted by the shunt field rheostat. Current division under load will depend on the compounding and proper adjustment of series shunts.

The pull-out torque of a synchronous motor varies with excitation. Reducing the excitation below the motor nameplate value will therefore reduce the pull-out torque of the motor. To obtain high pull-out torque, a correspondingly high value of excitation is required. In the case of intermittent, high-peak loads such as those on motors driving large log chippers, a series resistor may be provided in the field circuit.

This resistor is short circuited either manually or automatically when a large log approaches the chipper and until this log has cleared the chipper. As a result maximum excitation is applied and maximum pull-out torque obtained. Such intermittent use of maximum excitation is known as a field forcing. It is also used to increase the motor-starting capacity of generators.

Maintenance

Exciters should be installed in clean, well-lighted, dry locations with ambient temperatures not above 40 C, and should be cleaned regularly.

Too low a current density in the brushes is harmful. If the exciter is to be operated continuously at very low ratings it may be desirable to remove half the brushes in each group of brushholders. Contact pressure should be maintained at the value recommended by the manufacturer.

Where there is a substantial difference in humidity between seasons it may be necessary to change the grade of brushes twice a year, using a soft brush during low humidity and a more abrasive brush during periods of high humidity.

Commutator wear, resulting in high mica segments, will cause chattering and sparking of the brushes. Excessive vibration of the exciter may also cause sparking. Mica must always be undercut so it is below the surface of the copper commutator bars. Occasionally atmospheric conditions cause rapid blackening of the commutator. In such cases it will be desirable to obtain the brush manufacturer's recommendations on a more abrasive brush. It must be borne in mind that a chocolate colored coating is to be desired. THE END

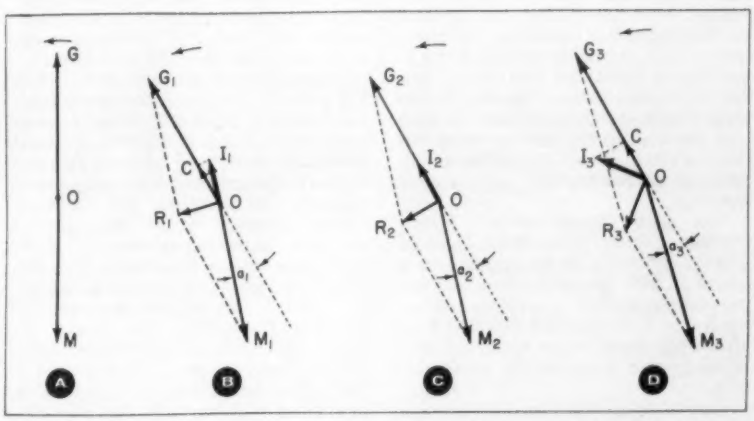


Fig. 3. (A) Hypothetical synchronous motor operating at no load with no losses, connected to a generator. (B) Load is applied, motor tends to slow down, operates at lagging power factor. (C) Excitation is increased, stiffening magnetic coupling, raising power factor to unity. (D) Further increase brings leading pf

Fig. 1. Instrument control for water-saving evaporative cooler (r) automatically keeps temperature in each stage to within 1 deg F

Fig. 2. Hiram Walker pioneered this continuous evaporative 5-stage flash cooler to ease drain on water resource. River water is used in the barometric condensers. See plan, Fig. 3

How Hiram Walker Wins Economy For Steam and Water Use

Recovery of all stillage, too, is being practiced in the thrifty operation of the world's largest whiskey and grain spirits producing unit. Strict conservation has minimized the problem of plant wastes

By C. S. BORUFF* and G. C. NEUREUTHER*

IN THIS AGE of increasing labor and material costs, it behooves each plant to operate in the most economical manner possible, commensurate with quality and service. In the distilled beverage industry, the excise tax has increased 854 per cent since repeal in 1933. With this tax now constituting the major portion of sales costs and with competition preventing the passing on of but little of the increases to the consumer, the best of production practices are essential.

The plant operations of Hiram Walker & Sons in Peoria are typical. This plant with an operating schedule of 15,000–20,000 bushels of grain per day and with a powerhouse capacity of 7000 kw and 500,000 lb of steam per hour, is the world's largest whiskey and grain spirits producing unit.

Cooking, distillation, evaporation, drying and cooling require sizable amounts of process steam and cooling water. At Hiram Walker every effort is bent toward maintaining the most favorable heat balance commensurate with good operating practice and toward diligent control of initial well water usage. The overall distillery and drier house operations are carefully integrated to give the steadiest steam load, coupled with the most economical use of steam and water.

Steam for processing is produced at 225 psig by means of powdered coal-fired boilers, passed through extraction turbines and distributed to plant processes at 80 psig and at 15 psig. If steam demand exceeds that passing through the turbines, the make-up comes directly from the boilers through regulating valves.

Uses of steam and water in a distillery vary with the ratio of whiskey to spirits. The higher the ratio of whiskey to spirits, the lower the steam and water consumption. Table I gives the amounts of steam used in individual operations at a level of 60 per cent whiskey and 40 per cent spirits, expressed as pounds of steam per bushel. These figures exclude steam for heating and other miscellaneous process plant uses.

Approximately one-third of the steam used in the cooking and cooker sterilization is recovered by means of a blowdown heat exchanger. This exchanger raises the discharge water from the still house condensers from 140 F to 180 F or more. Most of the heat economies effected in the distillery come through the reuse of the hot water from still condensers.

Table II gives the total water usage and a breakdown of in-plant reuse in the still house on a 60–40 per cent basis of operation.

Cold water usage in a distillery is appreciable. Table III is an example of the average amounts of water used in conventional plants.

Obviously, this quantity of well water usage represents a tremendous drain upon a water table. In the Peoria plant of Hiram Walker, three logical steps were taken to minimize this drain:

1. The stillage evaporator barometric condensers were changed to river water usage (item 4, Table III).

*Technical Director and Manager Distillery and By-Products Divisions, respectively, Hiram Walker & Sons, Inc

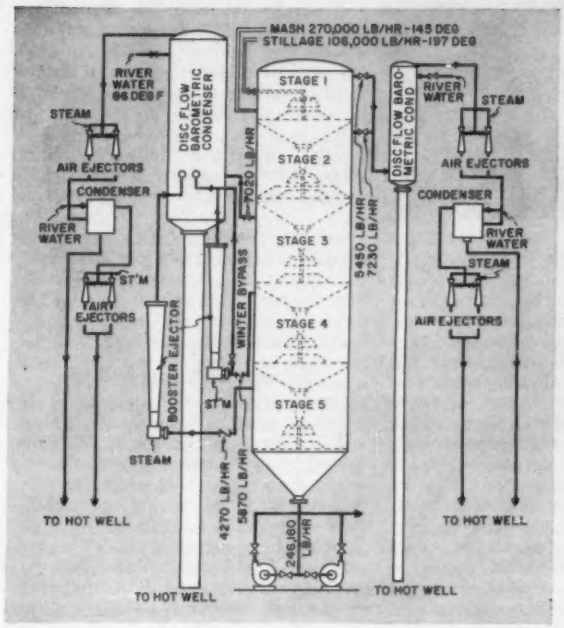


Fig. 3. Hot grain mash and stillage are successively cooled in five separate stages to fermenter-set temperatures. First stage cools from 195 to 145 F. Mixture is discharged at 70 F

Fig. 4. One-third of the steam used in cooking and sterilization is recovered in this heat exchanger. Water from still condensers is further heated here by cooker blowdown steam

2. The fermenter cooling coils were changed to permit river water usage (item 2, Table III).

3. A continuous evaporative five-stage flash cooler was pioneered and installed which employs river water in the barometric condensers. This replaced the double pipe mash coolers (item 1, Table III).

River water usage in fermenter cooling coils presents no problem as long as it is below 65 F. Judicious program planning permits its usage with a minimum of hardship in the summertime. The evaporative cooler allows mash to be cooled to 70 F with 90 F river water. River water usage in this cooler ranges from 155 gallons per bushel in the summer, when the river water reaches 90 F, to 70 gallons per bushel in the winter, with the water at nearly 32 F.

This raises the question, "Why not operate the still house on river water also?" Answer is that, as a plant processing grains into a product for human consumption, Hiram Walker's product protection policy requires that all in-process water, sterilizing water, and sanitary hot water must be clean and bacteriologically pure.

Since 65 per cent of the still house demand is reused as in-process hot water and since each gallon of water through the still house condensers picks up 90 Btu, it would represent a considerable cost to discharge heated river water back to the river and heat in-process well water with virgin steam. In this case, as in other cases within the plant, the most economical procedure, namely that of using river water for still house cooling and in-process hot water, yields to a lesser economical procedure for protecting quality.

Products

From each 56-lb bushel of grain mashed, a modern beverage distillery returns about one-third by weight as whiskey or grain spirits, one-third as carbon dioxide gas, and the final third as a destarched grain residue referred to in the industry as stillage. All of the stillage is recovered as distillers feeds. Only two other U. S. distillers besides Hiram Walker wash and recover CO_2 as bottled gas and dry ice. At Walker's this recovery is done by the Liquid Carbonic Corp.

Prior to prohibition in the U. S. in 1919, only a small portion of the industry's stillage was screened and dried to Distillers Dried Grains. Most of it was discharged to waste or fed directly, with hay, to steers. Both of the latter were accomplished with odor and pollution problems. With the advent of repeal in late 1933, research revealed the nutritional values present, and engineering and marketing studies led to complete recovery of stillage as Distillers Dried Grains with Solubles. A stable market was developed for this protein-fat-vitamin-yeast concentrate as a valuable balancing supplement in dairy and other mixed feeds.

Similarly, based on research, development and marketing studies,

Table I. Amounts of process steam used

Distillery and Drier House Operations	Pounds of Steam Per 56-lb Bushel
Cooking	21.0
Mash Cooling	4.0
Cooker Sterilizing	2.7
Fermenter Washing	3.4
Miscellaneous Sterilizing	1.0
Whiskey Distilling (80 x 60%)	48.0
Spirit Distilling (175 x 40%)	70.0
Rotary Driers	55.0
Evaporators	85.0
Total	290.1

Table II. Total water usage and in-plant reuse on a 60 per cent whiskey, 40 per cent spirits operating program.

		Cold Water (60F) Usage Gal/56-lb Bushel
Still House Water Usage		76
Reuse:		
Hot Water for Mashing	25	
Hot Water for Washing	15	
Hot Water for Miscellaneous	10	50
Hot Water to Waste		26

Table III. Cold water usage in a conventional distillery and drier house. Walker changed to use of river water

Operation	Cold Water (60F) Usage Gal/56-lb Bushel
Mash Cooling (double pipe coolers)	32
Fermenter Cooling Coils	67
Still House	76
Evaporators	170
Total	345

Fig. 5. Hiram Walker's plant on Illinois River at Peoria. Mashing capacity is 20,000 bushels a day. Aging capacity is at 1,250,000 barrels

Hiram Walker introduced in 1939, Distillers Dried Solubles, a dried concentrate of the soluble grain and yeast solids in stillage; and in 1949, another first, feed riboflavin from grain stillage. This latter product required "refermentation" with another microorganism. These last two developments and certain aspects of the recovery of Distillers Dried Grains with Solubles are covered by patents.

Distillery Process

Highest quality grains are preselected, cleaned and stored in the 1,250,000-bushel grain elevator adjoining the plant. Grains, except for barley malt, which is unloaded from special cars, are transported to the distillery from the grain elevator by means of airveyors. In the distillery, the grains, including the barley malt, are weighed automatically, cleaned once more and then deposited in concrete grain storage bins. Total grain storage capacity of these bins is about 105,000 bushels.

The grains from these bins flow by gravity to the roller mills where they are cut into meal. The meal is transported to storage bins by airveyors, which deposit it in the bins through cyclones and bag filters.

In mashing, the meal is weighed into batch pressure cookers through automatic scales at a dilution of from 15 to 18 gallons of hot water per 56-lb bushel of grain. Steam is introduced into the cookers and the corn meal cooked under pressure. The pressure is relieved and the cooker subjected to a vacuum induced by a barometric condenser and steam jets, reducing the temperature of the cooked grain for malting. Rye is mashed at atmospheric pressure. Barley malt in a water slurry is added to the cooker to convert the starches into fermentable grain sugars, the conversion taking place mainly in drop tubs which receive the malted cooks.

After the conversion, with concomitant pasteurization, the mash is pumped through a continuous vacuum flash cooler where it is cooled to the proper setting temperature and then pumped to the fermenter. In the fermenter, the mash is joined by a specified percentage of back stillage and pure culture yeast. During the 60 to 96-hour fermentation period, alcohol and characteristic distillate flavors are produced. Tempering coils maintain the fermenting beer at the proper temperature. After fermentation the ferment, or "beer," is dropped to a beer well. The fermenter is then washed with hot water and sanitized with chlorine water before reuse.

The beer is pumped through heat exchange equipment into the stills from whence it emerges as whiskey or grain neutral spirits, depending upon the mash bill and the distillation treatment.

Drier House

Spent grains from the base of the beer still are pumped to the drier house where they are converted into Distillers Dried Grains with Solubles or Distillers Dried Solubles.

The effluent from the base of the beer still, i.e., stillage, is pumped over a screening device. The effluent from the screens is centrifuged and sent to multiple-effect evaporators where it is concentrated to a syrup. The solids portion from the screens is pressed to reduce moisture further, mixed with syrup and recycled dried grains, and sent to steam-heated rotary driers for final drying. The product from these driers is the Distillers Dried Grains with Solubles. Some of the syrup produced in the evaporators is dried on drum driers into a high vitamin product known as Distillers Dried Solubles.

Results of Conservation

Production's first concern is the highest possible yield of uniform quality beverage products. While research, development and commercial scale demonstrations continue, it is felt that, in the main, production's primary goal is being achieved.

Complete recovery of stillage to various feed supplements has contributed substantially toward counteracting increasing materials and labor costs. It also contributes significantly to the feed and food economy of our nation. Today, the net income from the sale of feedstuffs pays the greater portion of those manufacturing costs incurred in processing grain to whiskey ready for barreling. This, of course, would not hold true without the conservation practices described above.

Minimizing plant wastes to our water courses to preserve this natural resource for further downstream use and reuse is a growing responsibility of all plant managements. Complete recovery of stillage has materially reduced the pollution population equivalent of grain distilleries. Only equipment clean-up wastes and the stillage evaporator tail pipe waters remain contributory.

Well-trained, experienced and alert personnel and the most advanced equipment and operating practices underlie Walker developments on steam and water economy. THE END

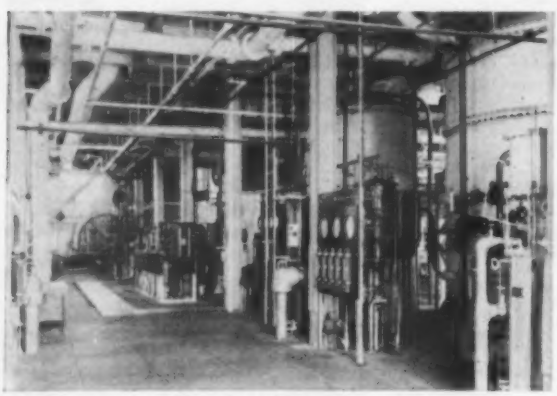


Fig. 6. View in distillery department. Cooling water from the still condensers is used as hot service water in plant. Different types of stills produce various whiskies, spirits

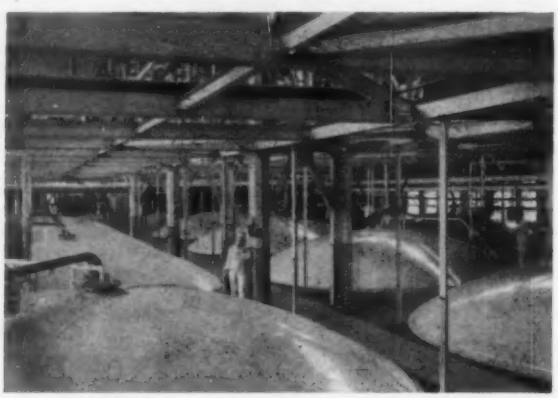


Fig. 7. In fermentation department, 24 100,000-gal enclosed fermenters are equipped with pancake cooling coils to maintain the desired fermenting temperature for 60–96-hr period

Will Your New Power Plant Be Really Modern?

This third, and final, article presenting latest developments in the design of equipments used in the modern power plant covers water control, pumps, valves, and ideas that simplify maintenance

By PAUL N. GARAY*

OPERATIONAL problems of high pressure plants are complicated by more stringent requirements for water purity. It is wise to take as much of the burden of water treatment from the operators as possible. Many of the standard chemical tests can be replaced by instrument detection methods. One of the most difficult tests, that of determining oxygen content of feedwater, is continuously and reliably performed by a "dissolved oxygen analyzer." It provides the precise measurement of dissolved oxygen in the feedwater which is required for successful plant operation.

Conductivity meters, of course, are an accepted instrument for water quality determination. However, to determine the amount of steam carryover into the turbine is a more difficult problem, since the presence of interfering gases in the steam, and variations in boiler water solids content, introduce errors into the measurement.

New Meters

Newest development for measuring the extremely small solids content of carried-over water is the use of a flame spectrophotometer. Comparison of the newer method's results with the results of the standard conductivity measurements reveals serious discrepancies in the results obtained with the old method. It is possible with the new method to measure the sodium content of the condensed steam with a precision of 0.00004 ppm.

Another important aspect of water control is measurement of pH. This, too, can be easily done by a standard pH instrument.

Ingenuity can be exercised to utilize various functions of standard equipment to provide new and desirable results. Good example of this is a boiler and turbine efficiency meter devised to indicate directly in per cent the efficiency of a boiler or turbine-generator plant. Such a meter will immediately reflect any change in the operating conditions.

Necessity for very high boiler efficiency requires that exit gas temperatures be as low as possible. But should the exit gas be colder than the dew point of the SO_3 in the flue gases, the SO_3 will condense on the air heater or at any other point where the temperature is low enough, resulting in a severe corrosion problem. The two approaches toward eliminating this problem are to neutralize the acid (or inhibit its formation) chemically, and to depress the dew point chemically so that acid will not condense on the metal.

Addition of dolomite or other compounds to the fuel oil is the earliest approach; it works, but there are problems of cost, and of keeping a solid in suspension in the fuel oil. Newer method is to inject cheap ammonia into the fire box in the ratio to fuel oil of about .06 per cent by weight, and the formation of the acid is inhibited. This method is inexpensive and simple, but in some cases may form hard deposits on the tubes. A new British patent calls for a sebacic acid salt of glyoxaldine added to the fuel oil in a proportion of 5 ppm, to inhibit corrosion efficiently.

High-Speed Pumps

Many new trends are resisted by the old guard as being unreliable, but such is not the case A. good example of this is the trend toward high speed machinery. There is no inherent design limitation on the speed of a rotating machine up to, say, 10,000 rpm. Of course, limits are imposed by centrifugal stresses and dynamic stresses. We have learned much in recent years to help anticipate and minimize such problems. As a matter of fact, a high speed machine has a built-in compensating factor in that vibration and dynamic stress problems are reduced by the use of shorter and smaller rotating parts. The bearing problems in high speed operations are reliably solved by the ball or roller bearing.

Good example of the necessity for high speed is the pump requirement for a high pressure boiler. Whereas a one-stage 3400-rpm pump can handle low pressures, say up to 150 psi, quite comfortably, the higher pressures being used in boiler feed service have been obtained by multistaging. Seven to ten stages are not unusual. Such a pump, naturally, is large and very expensive. Since the pump pressure goes up as the square of the speed, higher rotative speeds make single-stage pumping at high pressures quite feasible. There is a limit to efficient single-stage pumping, which is partly imposed by shock effects on the fluid going through the impeller at very high speed.

Turbine drive for a high speed pump is an inevitable choice, since a small, cheap turbine is quite efficient at high speeds. The turbine can be put on the same shaft as the pump impeller, and all coupling and alignment problems are eliminated. The complete machine is short and "unitized." A complete high speed b-f pump and its driver may well sell for about one-half of what its slower counterparts cost.

At the opposite end of the rotative speed scale we have the large, slow speed pumps. Design of such a pump is quite critical with regard to head, so the pumps usually incorporate some safety factor. Therefore, to reduce the need for over-design, and to accommodate system alterations, a large condenser circulating water pump has been developed in which the impeller vanes can be adjusted so that the pump will operate at its most efficient point even though the system might not meet the original design. The pump must be disassembled, however, for such adjustment.

The same manufacturer has developed a volute design for a large, low head pump which has the following advantages that make it superior to a mixed flow pump: more efficiency; a flatter head-capacity curve, which gives a lower shut-off head, and greater capacity at the lowered system head which results if one of a two-pump installation is shut off; won't overload the motor, so no interlock protection is needed; submergence requirements are reduced.

Regenerative Pumps

Use of regenerative or "turbine"-type pumps for boiler feed service, to this writer's knowledge, has never been seriously considered, but it is possible that their low efficiency might be compensated for by lower first cost, and the elimination of such problems as arise when two centrifugal pumps interact in a system. The turbine-type pump has a flat head capacity curve, so delivery is not dependent on pressure.

This is the same characteristic performance which is found in a reciprocating pump, and it may be one reason why some new installations have reciprocating boiler feed pumps. These new b-f pumps are available in multiple cylinders in large capacities. The drive is either by steam turbine, through a variable speed coupling, or from a fixed speed motor, but utilizing a variable displacement piston linkage built into the pump. This type of pump is fairly expensive but is the type of b-f pump unit required for the new once-through boilers.

*Associated with Kaiser Engineers, Div of Henry J. Kaiser Co

The variable capacity b-f pump discussed above is a rather special piece of machinery, but in the field of oil pumping, variable delivery is a common feature. It is not necessary to limit fuel oil pumping to a screw pump. Investigate the merits of a dozen different kinds of variable delivery oil pumps, with an eye to the possibility that such a pump might be used with a fuel oil burning system in which firing rate is controlled by pump delivery rather than by by-passes.

Hydraulic ash handling is rather common, but a variable delivery centrifugal pump is available which will pump the volume of slurry needed, without the need for moving vanes, valves, or by-passes. An internal by-pass is used to adjust the flow. In this same general field of use, a pump is available which will pass anything that will fit through the pipe. The pumped liquid does not actually pass through the impeller, so there is very little danger of clogging.

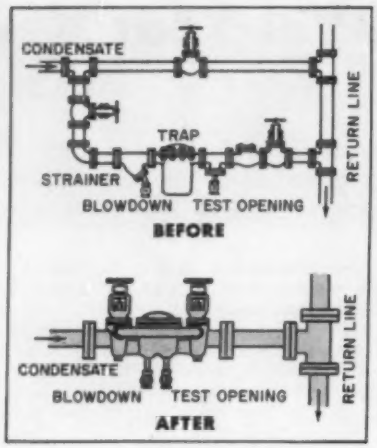
Last but not least, we have a novel use for a new type of equipment. In one utility plant a canned pump has been successfully tested for boiler feed service. Some saving was thought to be possible due to the elimination of packing and leak-off provisions.

Same type of centrifugal machine that pumps water will also successfully pump air. Consider the advantages of a centrifugal exhaust or vacuum blower in place of the cheaper steam jet air ejector for pulling of the main condenser vacuum. True, first cost is less on the air ejector, but operating costs are high. The rotary exhauster does not require steam, valves and other paraphernalia. Push the start button and there's your vacuum.

Centrifugal type of blower can also be used for pumping air pressures up to a couple of pounds, and has been used at higher pressures by staging. For economical higher pressures, however, there are many types of geared, lobed, or vaned types of positive displacement rotary compressors. These will deliver up to 30 lb of oil-free air and should be considered for instrument and pneumatic operating systems. As a general rule, it may be said that a rotary compressor requires less maintenance than the equivalent reciprocating unit.

Valves

To control these various pump and blower outputs, there is a variety of valves utilizing every conceivable method closure: gates, discs, sliding flat diaphragms, plugs, balls, pistons, and butterflies. The latter are of interest because they are cheap and reliable but unfortunately have not heretofore been suitable for elevated temperatures or pressures. Now one manufacturer has offered a butterfly valve for 2500 psig. Another design is for a butterfly valve with none of the conventional shortcomings, since



One way to simplify maintenance: steam trap which has integral by-pass

it seals tight on a 360-deg seat, and will withstand the same range of pressures and temperatures as any globe valve. One installation of these valves is in 150-psig, 700-deg gas service, in sizes up to 60 in.

In the interests of easy, remote operation, power-actuated valves are extensively used. A cheaper, and very satisfactory way to accomplish remote valve operation, is to use a pilot-operated valve. Such valves are operated by the pressure differential across the valve piston. Pilot valve serves only to direct the pressure to one side or the other of the operating piston. An additional advantage is that these will also operate as check valves. For economical remote operation, the pilot valve may be solenoid operated.

Maintenance Simplified

Maintenance of all these items of equipment is greatly reduced if proper lubrication is used. Lubrication, however, requires considerable manpower, and believe it or not, a fair degree of judgment with respect to frequency and quantity. Why not use a centralized lubrication system which can be remotely operated once a day, or as required? Such a system can be applied to one machine, or to groups, or to the whole plant, depending on how much tubing it is practical to install. Consider the savings in manpower and the peace of mind which results when the whole plant can be lubricated properly and effectively by pressing a button on the main panel board.

Further reduction in maintenance problems might be achieved by ordering the hot machinery to be fitted with aluminum bearings, which have shown themselves to be superior under some conditions to more expensive materials.

New advances apply not only to machinery and control, but to static systems also. Figure (above) shows the relative simplicity and low cost of a trap which incorporates by-passes, valves, leakage indicator, strainer, all into one body. The amazing thing about this kind of equipment is that it hasn't been brought out sooner. Our old friend, the labyrinth trap, is also available in a newer form which has no moving parts at all, and therefore requires no upkeep.

That old bugaboo of threaded piping systems, the leaky joint, can be eliminated by using a convenient little joint seal nut. Ordinary torques are sufficient to make a good screwed joint when using this seal. The joint can be disassembled and reassembled, and will still remain tight. Some of the cost and time usually required to install metallic tubing can be saved by using polyethylene instrument tubing. This material can be installed, using special plastic fittings, almost without tools. Connectors can be made leakproof by hand tightening. For neatness of appearance, the tube bundles can be laced together.

Emergency equipment which is ordinarily operated by gasoline motors will run equally well, if not better, on L.P. gas. The use of the L.P. gas fuel will result in better starting and running, since choking and warmup are not necessary. In addition, the exhaust does not have the dangerous CO that is present when gasoline is used as fuel.

Communications

Finally, the plant design having been reviewed, be sure that communications will be adequate. Consider the use not only of intercom circuits, but of two-way radio, and of wired or closed circuit TV. Radio is especially good for line-of-sight communication, where it is not desired to install a fixed phone station (for example, a roof or boiler-top repair job); the TV monitor will enable one man to watch several locations — the gage glass on the boiler, the operation of machinery, the coal yard, and even the main gate.

There are a few money-saving tricks which are not new, but are economical, nevertheless: use of a seismographic refraction survey instead of cored borings in foundation studies; use of an hydraulic jack to push an underground conduit under roads, etc; the control of temperature in heat exchangers by putting the regulator on the small condensate line instead of the big steam line. There are many other such methods.

These are but a few of the recent developments which may be of service to those planning new installations.

THE END

Want extra copies of Mr. Garay's 3 articles on modern power plant design? The first two appeared in the issues of September, 1958 and March, 1959. Write the Editor, or just jot Garay on the post card enclosed in this issue.

Fig. 1. View of attractive new plant. Note temporary panels in wall, and the blanked-off breeching in base of the stack

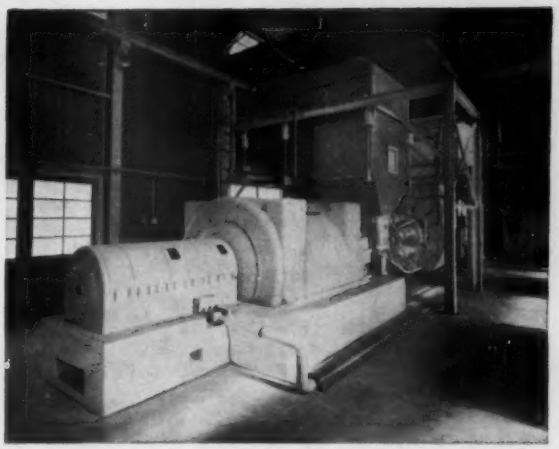


Fig. 2. Interior of the gas-turbine plant from the exciter end. Air intake, combustors and exhaust breeching are shown

New Peaking Gas Turbine Will Combine With Steam Unit for Base Loading

By GEORGE O. PHILLIPS *, F. L. SMITH † and L. L. NUNLEY †

POTENTIAL NEW economies in the generation of electric power are evident in the first six months' results from a 10,000-kw gas turbine installed by the City of Monroe, La, last July. Monroe is a city of 49,000 people in the northeastern section of the state.

Largest unit of its kind when it went into service, the Monroe unit is intended for eventual operation in conjunction with a new 16,500-kw steam-turbine generator.

When this steam turbine is added to the system, recovery of waste heat from the gas-turbine exhaust and consequent excellent economy will result from operating the two together as a compound unit. This will be discussed in detail below.

At the present time, the Monroe gas-turbine unit is used only on peak loads. For this purpose, it was preferred to a steam turbine for two principal reasons — it was possible to purchase and install the unit in about one-third the time that would have been needed for a steam plant, and even more important, it can be started up to meet peak loads in a matter of minutes as compared with hours for a steam turbine.

The new installation is believed to represent a highly-promising pilot operation, pointing the way to badly-needed economies in generation to meet rapidly increasing power requirements in many areas of the country, with a capital outlay that is within feasible limits.

Rapid expansion of air-conditioning load since 1950 has of course had tremendous impact on the utilities of the South. Their peaks already came during the summer and the new load naturally coincided with and added heavily to maximum requirements.

Monroe, La, shared this experience. In August, 1947, the peak load was only 8600 kw. Ten years later this peak had grown to 30,600 kw, more than 3000 kw over the system's firm capability (determined by deducting the largest unit from the installed capability, 34,500 kw).

Between 1950 and 1955, a total of 22,500 kw of new capacity was installed in three equal units. This effectively tripled the previous system capacity in a span of only six years.

Initial Engineering Survey

Despite this rapid expansion, daily peaks were breaking into reserve capacity by early summer of 1957. The Commission felt that another year of growth would eliminate the reserve — a suspicion that was supported by an independent engineering study and later confirmed by experience.

Immediate problem in Monroe was to provide new capacity in something less than a year. The long-range view required that the new capacity fit eventually into a high-efficiency, dependable over-all development.

As indicated by the initial studies, a gas-turbine generator proved the complete answer to the immediate need, as well as a logical first step toward the ultimate objective. It could be installed in the time available. Its inherent characteristics, plus the integral control features included in its design, fitted it ideally for peak service.

Another interesting aspect of this station is that the entire plant is operated by 32 employees, and it was possible to add the new unit without increasing this number. The unit is located in a new building next to the existing facilities, but its controls are convenient to the central control panel in the main building. Only one man is needed at the gas turbine to start it, and he can leave it after 15 minutes.

Daily starting and stopping is of no particular concern with this type of equipment, and in addition, it can be started very quickly in a situation of impending emergency.

Installation, designed and supervised by Ford, Bacon & Davis, Inc, was completed during June, 1958, allowing a few weeks for trial runs. It went into commercial operation over the Fourth of July weekend, and operated almost daily except for weekends throughout the summer months.

Operation has been completely trouble-free. Although it has been in operation only a few months, it has already demonstrated its value in its second function of emergency starting. On that occasion, the unit actually logged a 13-minute start-up.

The unit was supplied by General Electric, and consists of a 10,000-kw gas-turbine drive and a 12,500-kva generator. Since system power factor is about 88 per cent during peak intervals, full-capability operation is possible.

Fuel is natural gas, which is also the fuel for the steam installation. Two motor-driven gas compressors have been provided.

This and other similar provisions,

* Vice-President, Ford, Bacon & Davis, Inc, and † Manager of Utilities Comm, and Manager of Power Plant, respectively, City of Monroe

Table I. Pertinent heat-balance figures for completed power plant. Gross generation values are for the new steam turbine

Gross Generation

4,130 lb per hr (159.1 Btu per lb)	=	657,100 Btu per hr
10,610 lb per hr (290.6 Btu per lb)	=	3,083,300 Btu per hr
112,120 lb per hr (445.6 Btu per lb)	=	49,960,700 Btu per hr
Total Used Energy	=	53,701,100 Btu per hr
Internal Losses (4.67%)	=	2,507,800 Btu per hr
Gross Generation	=	51,193,300 Btu per hr
	=	15,000 kw

Heat Rates

Steam Unit Operating Alone $= \frac{201{,}900 \times 1025}{15{,}000} =$ 13,796 Btu per kwh

Combined Operation of Gas Turbine & Steam Unit $= \frac{279{,}000 \times 1025}{9215 + 15{,}000} =$ 11,810 Btu per kwh

Boiler

Heat Output = 127,160 lb per hr (1248.3 Btu per lb) + 3820 lb per hr (325.3 Btu per lb)	=	159,977,000 Btu per hr
Waste-Heat Recovery	=	56,300,000 Btu per hr
Heat from Combustion	=	103,677,000 Btu per hr

Fuel Consumption

Without Recovery $= \frac{159{,}977{,}000}{1025 \times 1000 \times 0.773} =$ 201.9 mcf per hr

With Recovery:

By Gas Turbine (At 9215 kw load)	=	160.0 mcf per hr
By Boiler $= \frac{103{,}677{,}000}{1025 \times 1000 \times 0.850}$	=	119.0 mcf per hr
TOTAL		279.0 mcf per hr

which were installed at moderate extra cost over bare minimum requirements, give reasonable assurance that, short of a failure in the main unit itself, capacity will not be reduced by more than 5,000 kw under any of the more likely trouble conditions.

Long Range Design

The ultimate objective of fitting this new installation economically into a long-range plan for high-efficiency operation required incorporation of some special provisions in the original design.

It is well known that extremely good over-all efficiency is obtainable when superposing on a steam cycle, if the gas-turbine exhaust is used for combustion air and economizer heat recovery. With this in view, the exhaust duct was made much longer than would have been required for the gas turbine in independent operation. It was laid out to permit future connections to the eventual steam boiler which, incidentally, will re-use the stack provided for the gas turbine. Space was provided for the installation of dampers to permit either joint or independent operation of one or both units.

When the steam unit goes into service, the two in joint operation will achieve an overall efficiency about 10 per cent better than that which might be expected from two steam turbine units of about the same total capacity. This combination will be by far the most efficient equipment in the station, and at that time it will be base loaded. Since the gas compressors will require periodic dismantling, provision has been made for installation of a third compressor for base-load operation.

Naturally, in order to make these preliminary provisions, it was necessary for us to develop the planning of the future steam unit well in advance of its procurement. A 16,500-kw preferred-standard turbine generator is proposed, subject, of course, to any later revision of capacity which may be indicated by load trend. The boiler will be of 175,000 lb-per-hr capacity, substantially larger than would normally be required for the unit.

Because of its heat-recovery connection, the new steam generator will be substantially more economical than the existing units. The excess capacity will be used through a pressure reducer-desuperheater as part of the supply to the existing units, with a resultant net fuel saving. This excess capacity will permit the shutdown and eventual removal of an old low-pressure boiler which furnishes some of the steam to two small units, one of 2500-kw and the other of 3500-kw capacity.

New steam-unit installation will be much simplified, as compared with normal practice in independent units, to take full advantage of possible heat recovery by the economizer. Since air preheaters have no application in such joint operation installations, the limit of heat recovery is established by feedwater temperature entering the economizer. Regenerative feedwater heating to high temperature is not economic under this circumstance; it merely increases stack loss, so such heating has been minimized in our design.

Heat Balance Requirements

Only two of the four bleed steam connections available will be employed. The high-pressure bleed will supply an evaporator only; a secondary supply will be provided through a pressure reducer from the steam main to permit independent evaporator control at low loadings. The evaporator output and drains will normally be adequate to supply the deaerator, so that no bleed steam connection is provided for this.

Deaerator likewise has a secondary source of pressure-reduced steam in order to maintain its pressure at a minimum of 5 psig. The only closed heater in the cycle will obtain its steam from No. 3 bleed point. This heater will be partially bypassed on the water side by an automatically-controlled valve impulsed by the water temperature in the deaerator storage tank. Water temperature leaving the deaerator will thus be stabilized in a narrow range, 228 F, when the deaerator is operating pegged at 5 psig, to 233 F in normal operation. Stack temperature will be maintained between 380 to 385 F.

It is possible that the closed heater function will be replaced by a stack water heater, provided experience with the early installations of this type of equipment proves satisfactory.

Compared to a normal four-heater cycle, this simplification achieves substantially better efficiency during joint operation, and a considerable saving in first cost. It sacrifices a degree of efficiency during periods of independent operation of the steam unit alone, but in the overall view this is of little consequence. At about 90 per cent load on the two units, the combined fuel rate will be about 11,800 Btu per kwh based on high heating value, or 10,700 Btu per kwh based on low heating value of the gas.

Total cost of the gas turbine generator installation, including site preparation, building and accessory equipment, was $1,748,000. The original estimate of approximately $2,000,000 was thus bettered by 12.5 per cent due principally to a favorable equipment market.

A report on this project would not be complete without describing a small but important activity which was also undertaken at the same time. When design work started on the gas-turbine installation, a study was initiated to improve operation of the existing steam equipment.

Still in progress and nearing completion, this study had three objectives — improved dependability, better fuel economy and lower station-power consumption.

Results so far have been extremely favorable. Moderate strengthening of the auxiliary position, by installation of an additional water-circulating pump and valving, has reduced the reserve capacity requirement for all emergencies, except unit failure, from 7,500 kw to 6,000 kw, with resultant improvement in dependability.

Fuel consumption per gross kilowatt-hours produced has been cut by over five per cent. Auxiliary power consumption has been progressively reduced. In the first non-peak month of operation after the program was put into substantial effect, it was down 18 per cent from the same month of the preceding year. THE END

Portable Grinding Is Easy This Way

Large grinding jobs using hand tools can be both time-consuming and laborious. When work must be held to reasonably close tolerances, this unique grinding rig can be used to advantage with savings in both time and money

By WILLIAM BUCKSHEE

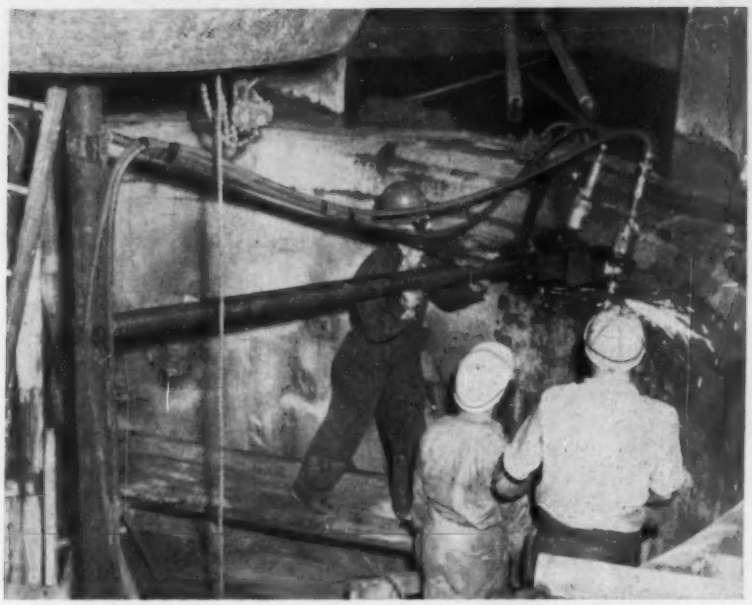


Fig. 1. View showing novel method used to center column of the portable rig

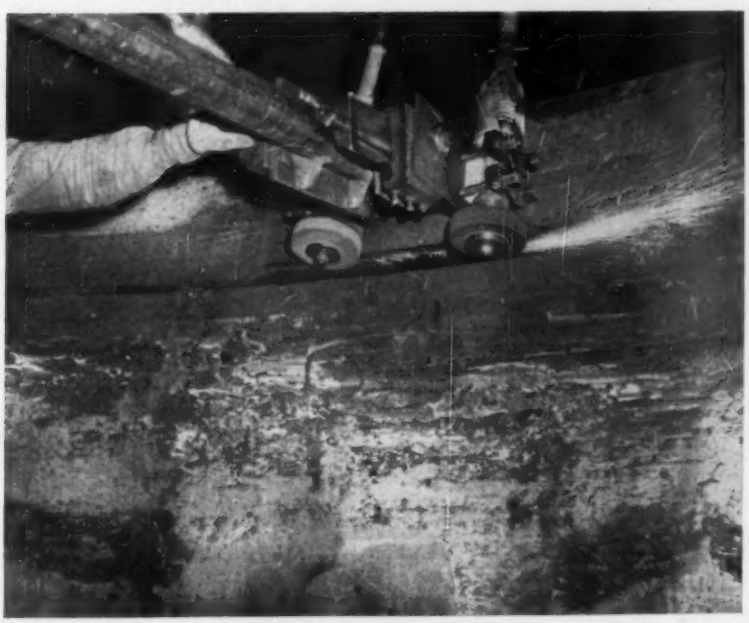


Fig. 2. Air-driven grinders with cross feeds similar to lathe did the work

FOLLOWING EXTENSIVE welding repairs to the inner surface of a badly cavitated throat ring of a 35,000-hp hydraulic turbine, it was discovered that the ring had warped and had assumed an oval shape; this to a degree where outer edges of the runner blades fouled the throat ring. Runner is of the propeller type and weighs 42 tons.

Since much of the welding overlay was of stainless steel, there was only one feasible method of returning the ring to original shape and contour. This was by grinding, and since nearly 3/16 inch of metal had to be removed, this would have been a laborious project with air-driven hand tools.

Hand grinders are quite adequate when smoothing out a surface following a welding job. In this case, however, such an operation would have been time consuming, costly and laborious.

After a couple of days of muscle-straining work, one of our gadgeteers came forward with the contraption shown in the photographs.

While the device in itself is quite simple, a brief description of its installation should be of interest. To make use of such a rig with fair accuracy, reasonably true centers had to be established. Since the head cover was in place, a center was picked up in the opening which normally takes the guide-bearing for the turbine shaft. This can be seen in the upper left corner of Fig. 1. A plumb bob was then dropped to the turbine cone below, where a center was marked. (*Editor's note:* The cone on propeller type turbines is a concrete pillar set in the center of, and directly under, the runner and serves to help eliminate turbulence as water leaves the runner.) On top of this cone a steel cap was fitted, in the center of which a ball bearing was located. In the head cover opening, a bracket was installed to take a top bearing.

In these bearings, a vertical column consisting of 3 inch pipe was fitted. To the vertical column an arm made from 2½ inch pipe and a diagonal brace were clamped in such a manner that different settings in elevation were possible.

At the end of the horizontal arm, two air-driven grinders were affixed using cross-feeds similar to those on a lathe. One grinder was set above the other so that with each swing of the arm, cuts of different depths were obtained. Two workmen swung the arm back and forth through an arc of better than 90 degrees, adjusting the feed as required.

It is estimated that this rig quite easily saved two weeks of laborious grinding by hand, and with much greater accuracy, resulting in a well finished appearance. THE END

West Germany Makes Pumped

Pumped storage hydro power for peaking purposes, commonplace in Europe, has long intrigued utility companies in U. S. Here's how West Germans do it

By Dr.-Ing. RUDOLF MEISTER

WHEN DREDGING PROJects in the Port of Hamburg area and in the lower Elbe basin resulted in excessive soil erosion and undesirable lowering of the water level upstream, Hamburg's Conservation Authority took dramatic counter measures. Result is the world's newest successful pumped storage hydroelectric installations, Fig. 1.

Pumped storage plants exert a favorable effect on load conditions of steam power plants in several directions. They are extremely desirable as peaking units because, unlike steam stations, they are immune to heavy load fluctuations. In daytime they tend to level out the valleys of system load curves by applying the pumping load. Then, during the evening peak, they increase the system load capability with an attendant overall system efficiency increase.

Thermal Efficiency Benefits

Such stations also exert a pronounced effect on thermal efficiencies of steam plants by reducing the frequency of starting and stopping boilers and turbines. Too, such an installation provides valuable stand-by capacity, available almost instantaneously in the event of forced outage of thermal equipment.

Hamburg Electric's Geesthacht Station achieved full operation status in October, 1958, with three 35,000-kw units. This total of 105 mw will be doubled in the near future with a duplicate installation, intakes for which are already in place. These latter were provided during construction of the first phase of the station to avoid interruption of service at a later date.

Storage basin for the first three units has a minimum storage level of plus 255 ft above datum level. With maximum storage at plus 300 ft above datum level the storage basin holds about 4.3 million cu yd of water, corresponding to 580,000 kw. Water surface at maximum storage level is roughly 318,000 sq yd; at minimum storage level it is 227,000 sq yd.

Figure 2 shows the arrangement. Storage basin has been provided as near to the Elbe River as possible in order to shorten the runs of pipe. Basin, bordered on the north by the Hamburg-Berlin highway, is roughly 2000 ft long and 1660 ft wide. Intake construction was provided at the south end of the storage basin. From there the pipelines lead to the power house on the river. Pipe track as well as the sites of the intake and power plant were located in positions where minimum earth-removal was required.

Fig. 1. Photo showing new Geesthacht hydroelectric station near Hamburg, Germany. Note location of the storage basin with relation to the turbine hall

Track of the after-bay race canal was determined as the result of model tests so that river-borne traffic would not be affected by plant operation.

During construction of the plant, total earth removal consisted of 2.6 million cu yd. Of this amount, about 1.96 million cu yd were built into the embankments and mechanically compacted.

Novel Sealing Method Used

Methods used to seal the basin are of interest. For the bottom seal, 2 in. of bituminous sand topped by a 2.36-in. layer of asphalt fine-grain concrete was used. The asphalt concrete layer contained a small percentage of chippings and was finished in two overlapping layers. Such a sealing layer will be in position to follow possible dislocations of the underground and will withstand temperatures from −22 F to 140 F.

Embankment seal consists of a 2.75-in. cover of asphalt fine concrete with a large percentage of chippings, applied in two overlapping layers on a 2-in. layer of bituminous sand. Both bottom and embankment seals are covered with a thin layer of gum mastic. Embankment, with an inclination of 1:2.5, is not expected to show any surface warping even under prolonged exposure to temperatures up to 140 F.

Oil-hydraulic actuated drop gates, 17.3 ft wide and 16.6 ft high, and quick-acting throttle valves with falling weights, have been built in. An emergency lock is provided by stop-plates designed to be inserted in the slots of the adjustable rakes. Intake structure, 173 ft long and 60 ft high, is equipped with a gantry crane so that rakes, stop-plates, drop plates and throttle valves in the shafts are accessible.

To obtain simple hydraulic conditions, each generating unit is supplied by one steel pipeline. To avoid low-pressure conditions under extreme operating circumstances, a straight line track with one bend was chosen. Average pipeline length is 2,040 ft from basin intakes to the generating units. Intake arrangement is shown in Fig. 3.

Generating station is a roofless trough-shaped structure. Protection

Storage Hydro Power Work

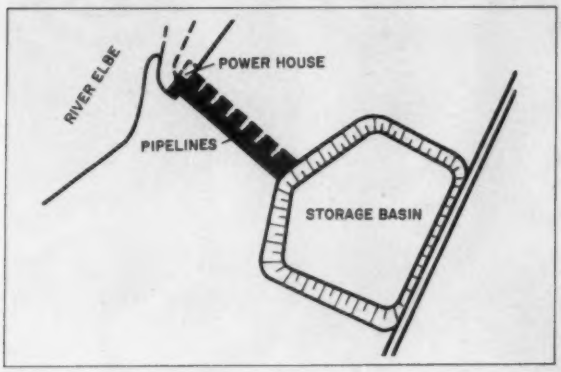


Fig. 2. Plan showing arrangement of the Geesthacht station

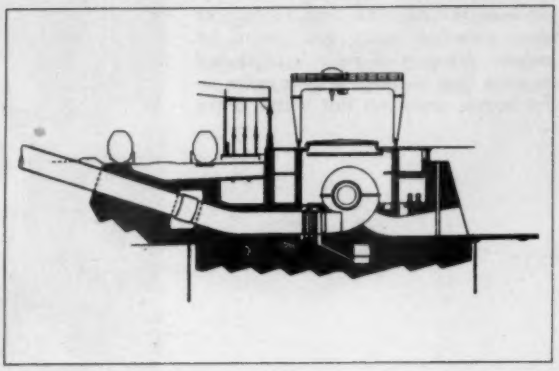


Fig. 3. Sectional view of station shows turbine arrangement

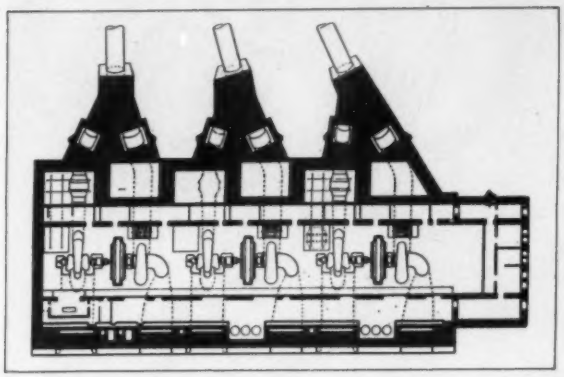


Fig. 4. View showing location of the turbine and pump units

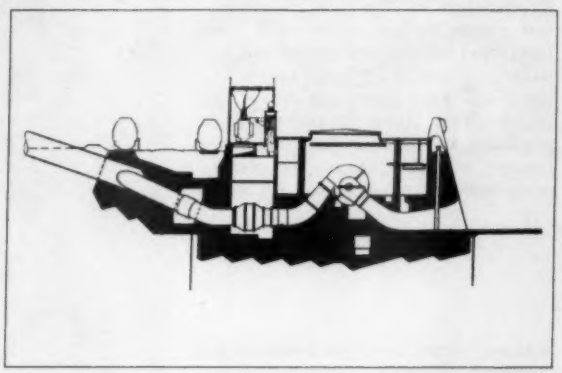


Fig. 5. Sectional view of station shows arrangement of pumps

is afforded the turbine hall by hatch covers similar to those on sea-going vessels which rest laterally on two concrete girders. Turbine hall proper is 330 ft long and 53 ft wide.

Minimum dimensions were determined by necessary inlet and discharge connections of pumps and turbines and locations of the fixed points for discharge pipes. Above the inlet and discharge connections, on the river side, are located the cooling water pumps, ventilation air compressors, air chambers, turbine governors and an emergency diesel set. Figure 4 shows arrangement of the generating units in the turbine hall.

These Have Horizontal Shafts

Generating units have horizontal shafts and consist of a turbine, a motor-generator and a pump designed for 214 rpm; maximal (racing) speed is 455 rpm. The Francis turbines are rigidly connected to generators having a maximum capability of 59,000 hp, or 43,500 kw. Rated generator output of 35,000 kw is firm at an effective head down to about 250 ft; it drops to 32,000 kw at minimum effective head. Water quantity in the turbines ranges between 66.7 and 78.5 cu yd per second. Maximum efficiency percentage is about 91.5.

One-stage storage pumps, with two intake elbows at medium manometric head, pump about 43 cu yd per sec. Power consumption is roughly 41,000 hp, or 31,000 kw. Three of these pumps will fill the storage basin in slightly more than nine hours. When the plant is enlarged to the anticipated six-unit capacity, it is estimated that four pumps will be required to feed the full-capacity plant.

Pump impellers are made of cast manganese alloy steel. The pump is clutched to the stopped electric motor by a disengageable gear clutch. It was not felt that a starting turbine for the pumps was necessary, and this has been eliminated. Starting the set for pumping purposes is effected by the turbine which runs ventilated after paralleling the synchronous machine. Maximum pumping efficiency is 90 per cent.

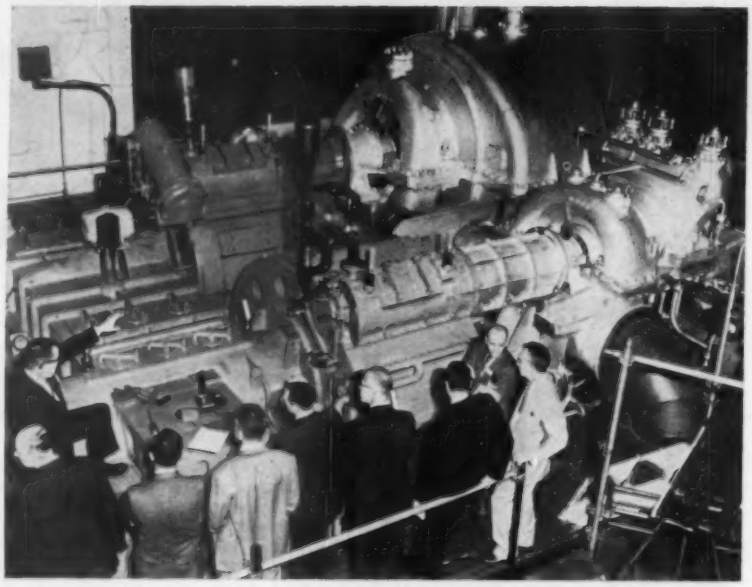
Generators are rated at 43.75 mva; voltage is 10.5 kv, which is standard throughout Germany. Exciter dynamos and pendulum type generators are located in the machine housing. Generators can be overloaded up to 50,000 kva for 30 min, so that peak capacity of the three-unit plant, with storage basin filled, is about 120,000 kw or 14 per cent higher than rated capacity. Rated power of the generator when operated as a synchronous motor is 34.5 mw. Rated power of pump and motor have been adjusted in such a way that pumping even at 52 cycles cannot lead to overload of the motor.

Machines can either be put into operation at the control panel of the plant, or directly by the load dispatcher in the administration building of the Hamburgische Electricitats-Werk, by-passing the district panels. Starting operation is largely automatic. In the event of any system failures or forced outages, the station can be put into operation in less than 100 sec. THE END

Want Extra Pages of Articles?

No need to tear up your copy of POWER ENGINEERING. We'll be glad to furnish you extra pages of articles. Just write the Editor on your letterhead or use the enclosed post card, and jot down the title that interested you.

Inside a dust collector at Rivesville, W Va, station of Monongahela Power Co. This Hagan secondary collector was opened for inspection after endurance test of more than 10 tons of dust collected daily for about 14 months. Absence of wear is attributed to even flow distribution over entire inlet nozzle area, no flat waste areas

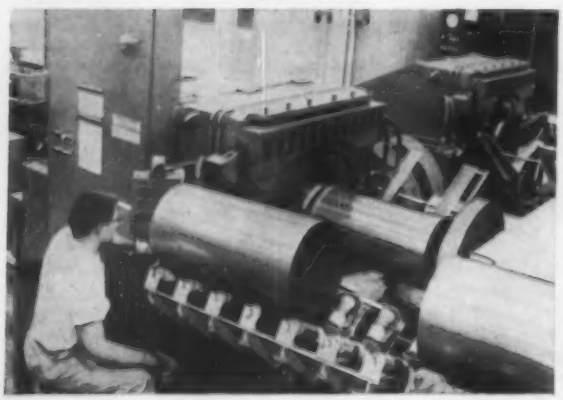


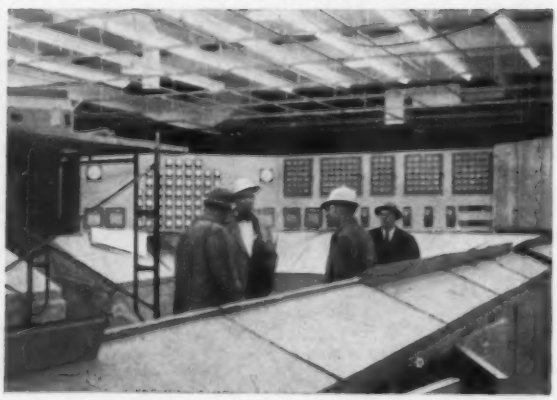
Propulsion for the *N/S Savannah*—first atomic surface vessel—will come from these turbines and reduction gear, under test here at De Laval Steam Turbine Co. This machinery can deliver 22,000 shaft hp. Steam for power will be produced by B&W pressurized water reactor, will keep ship running continuously without refueling for 3½ years

Below, right, POWER ENGINEERING editors pay a visit to Dresden Nuclear Power Station near Joliet, Ill. Looking around partly-completed control room: Bob McCaw, Jeff Hunnicutt, Howard Gann of Dresden staff, Welden Reynolds

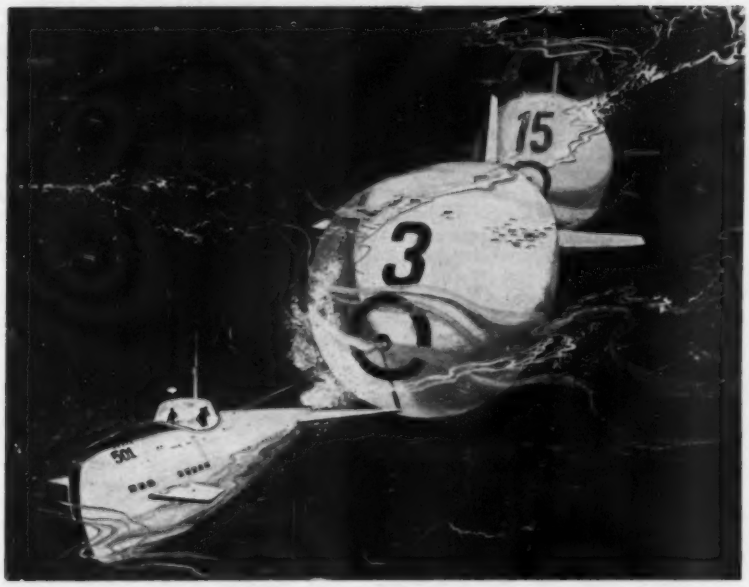
Automated to the hilt, new Westinghouse plant at Athens, Ga, turns out distribution transformers. Here dual gravity conveyors send tanks to machines that bead and flange tanks. Shells are then fed to welders and punches, all sequenced by Cypak static controls

POWER ENGINEERING'S





Ingots for turbine rotors and other components of high-speed rotating machinery will be produced by this new stream degasser at Standard Steel Works. Foreman checks progress through viewing window (center) as heat of low-hydrogen electric furnace steel is poured into degasser. This is sixth such unit in American industry



Underwater shipping by nuclear-powered submarine tug is the ingenious idea of P. J. Carroll, M.E. of Dublin, Ireland. Tug tows a string of underwater cargo vessels, can take full advantage of ocean currents and sub-polar routes. Cargo could be transported and delivered without surfacing. Carroll's idea won prize in contest of Mars pencils

NEWS REEL

Japan bound (below, left) is a generator of 505,240 lb made by G-E for the new Sendai station of Tohoku Electric Power Co. To load, huge over-head crane had to be borrowed from the Navy. Designer of Sendai was Ebasco

Last toot for the "America" finds famed Barnum & Bailey steam calliope on its way to Circus World Museum in Baraboo, Wis, as gift of Cleaver-Brooks. The company acquired it in 1952 for promotion purposes, refitted it with package boiler and generator

Industrial Power Plant Accounting

By JOHN S. COLE, P.E.

Last month the author started this timely series by telling how to set up cost data for operating economy. Power engineers will want to refer to that article as Mr. Cole now tells how to . . .

Use Cost Data For Departmental Charges

FUEL OIL COSTS can be analyzed in the same manner as coal (see POWER ENGINEERING for April), and with the same factors affecting the costs. Let us see how such an example would work out. In general, the most convenient figures to use in computing fuel oil costs are units of 1000 gallons. This eliminates the necessity for working with very small fractions of a cent, as would be the case if the problems were worked on a per-gallon basis. After cost per 1000 gallons is computed, division of this cost by 1000 will result in cost per gallon. Table I shows how cost of fuel oil, as fired, can be computed.

Now assume the boiler in the previous example was fired with No. 6 fuel oil having a heating value of 148,500 Btu per gallon. There would, in all probability, be a loss of about 2 per cent in boiler efficiency due to hydrogen in the fuel oil, and excess air required for good combustion. In that case, the heat to be supplied in the boiler would be:

$$\frac{1020.4}{.78} = 1308.2 \text{ Btu per lb of steam}$$

This would require:

$$\frac{1{,}308{,}200}{148{,}500} = 8.81 \text{ gal. oil per 1000 lbs of steam}$$

This oil would cost $.0684 \times 8.81 =$ 60.26 cents per 1000 lbs of steam.

Two examples already computed show that there is a differential of 3.56 cents per thousand pounds of steam in favor of coal as fuel. If the plant generates 50,000 lbs steam per hour, this would amount to a saving of $1.78 per hour, $14.24 per 8-hour day and $284.80 per working month. The engineer who operates a dual-fuel plant must keep a running account of his fuel costs so he can determine which adds the least cost to his operation, and can switch fuels as economics dictate.

It has been shown how each over-all plant operating dollar is split up. Now to see how the fuel dollars look when they are spent. The coal dollar could be broken up as in Fig. 1. The oil dollar could be split up the same way and appear as shown in Fig. 2.

With the delivered cost of fuel determined, the next step is to see what steam made with that fuel costs. Again, this cost is determined by seven factors. Operating and maintenance labor cover complete labor charges necessary to generate steam. This covers all charges for operating the boilers and their auxiliary equipment, as well as charges for fuel from storage to the burner.

Internal power charge covers all use of utilities for feed water pumping and heating, ash removal, pulverizer or stoker drive, forced and induced draft fan power, soot blower steam and cost of boiler feed water delivered to pump suction.

This cost can best be tabulated on the same basis as the fuel costs: on units of 1000 lbs of steam generated. These costs would probably be in the range of those shown in Table II.

How To Charge Your Customers

Since steam is one of the basic utilities required for plant production, each section which uses steam should be charged for that usage. In order to make the steam pay for itself, it will be necessary to add to the basic cost certain other costs. A capital expenditure was necessary to install the steam distribution lines. Maintenance labor is required to keep these lines in top condition. Materials and supplies are necessary in the performance of this maintenance. Finally, there are unavoidable line losses which occur during transmission of steam from point of generation to point of use. With a generated steam cost of 98.2 cents per 1000 lbs, an equitable cost for steam at the point of use would be from $1.20 to $1.30 per 1000 lbs. and departments using steam should be billed at that rate.

Don't Forget Station Service

Any steam used in the utility section should be billed back to that section at the generated steam rate. As an example, suppose the plant has a 2000-kw condensing turbine generator having an average rate of 24 lbs steam per kw-hr. Such a unit would require 48,000 lbs steam per hour. Cost of this steam would be $48 \times .982$ or $47.14 per hour or 2.357 cents per kw-hr.

If the turbine operates at a back-pressure, say, of 20 psi, then steam cost must be adjusted. Most convenient way to make this adjustment is on the basis of percentage of heat in the exhaust steam that is available for use elsewhere.

Suppose enthalpy of steam at the turbine throttle is 1290 Btu per pound, and at a 20 psi exhaust the enthalpy is 1110 Btu per pound. Then 1290–1110 or 180 Btu per pound has been used to generate power. Thus, 14 per cent of the heat has been used for generation, and 86 per cent remains for use elsewhere. In that case, steam chargeable to power production would be:

$.14 \times 48 \times .982 = \$6.69$ per hour.
Steam cost per kw-hr would be:

$$\frac{6.69}{2000} = .003345$$

Since only 86 per cent of the initial heat remains in the steam, departments which use low-pressure steam should be billed at 86 per cent of the cost of high-pressure steam. This would range from $0.90 to $1.10 per thousand pounds.

The dollar which is spent by the plant to produce steam for power, heating and process as outlined above could easily have an appearance similar to that shown in Fig. 3.

Another basic utility required for production of finished product is electrical power. Here again, each operating section should be charged for the power used by that section, and the price set should cover basic cost of power plus the other charges to cover all power costs.

Some plants purchase all the power used, some purchase part and make part, and others generate all of their power requirements. Regardless of source, there will be a basic charge for each kilowatt hour at a given point in the system.

In practically all cases, this will

Fig. 1. The fuel dollar, burning coal

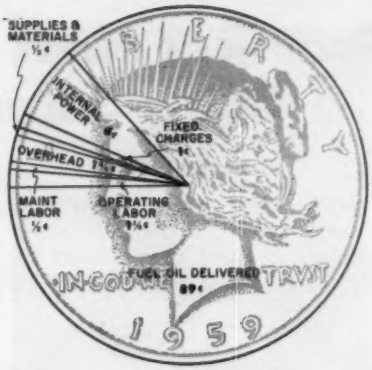


Fig. 2. The fuel dollar, burning oil

Fig. 3. How steam costs are divided

be the plant bus, or distribution center. If all power is purchased, only six factors go into cost of power as distributed. Those factors would cover operating and maintenance labor, overhead, supplies and materials, fixed charges, and the cost of power, purchased at the utility company meters. Operating labor would be a very minimum charge, just enough to cover actual switching operations at the station. Practically all labor charges would be applied to cover maintenance of the primary and secondary substations, and the distribution system. Overhead charge would be applied on the basis of the labor charge. Fixed charges would cover depreciation, taxes, interest and insurance on the primary and secondary substations and distribution system.

Since most large power users install their own primary substations, power is metered on the incoming side of primary transformers. Therefore, the charge for distributed power must be large enough to cover losses in both primary and secondary transformers, as well as any losses in the distribution system.

As a rule, it is best to bill operating departments at a flat rate per kw-hr, rather than attempt to apply a sliding rate scale, regardless of whether power is generated or purchased.

For 100 per cent purchased power, let us assume the rate structure under which the plant operates is such that the averaged power charge amounts to one cent per kw-hr at the primary side of the main transformer. Power costs could then be broken down as shown in Table III.

Account for System Losses Too

To break even on this power, it would be necessary to bill it out to the operating departments at the rate of $0.017 per kw-hr.

If power is generated rather than purchased, seven factors must be considered. These are: 1. Cost of steam to generate; 2. Operating labor; 3. Maintenance labor; 4. Overhead; 5. Supplies and materials; 6. Fixed charges; and 7. Internal power.

Cost of steam would be just that amount chargeable to generation of power if generating equipment is used on a back-pressure or extraction basis. Charge for generation would be only that percentage of heat in the steam actually used, as shown in the preceding example.

Costs of generated power could be broken down as shown in Table IV.

It is necessary to add the distribution charges to the generating costs to arrive at a fair price for this generated power. With a good distribution system, these costs average about 6 per cent of the generating costs, or about .008 cents. Thus, this power would cost .01494 cents distributed. It should be billed out at .017 per kw-hr to the operating departments to break even.

More to come . . .

The author will continue his discussion of industrial power plant accounting practice in an early issue of POWER ENGINEERING

Table I—Fuel oil cost as fired showing cost distribution

Oil cost, per 1000 gallons	$60.00
Delivery charge	1.00
Operating labor	.80
Maintenance labor	.30
Overhead	1.10
Materials and supplies	.30
Fixed charges	.80
Internal power (atomizing and heating steam, pumping, fans, etc.	4.10
Cost as fired, per 1000 gallons	$68.40
Cost as fired, per gallon	$.0684

Table II—Generated steam costs showing cost distribution

Delivered fuel costs per 1000 lbs steam	$.488
Operating labor	.019
Maintenance labor	.024
Overhead	.043
Supplies and materials	.020
Fixed charges	.044
Internal power	.344
Steam costs per 1000 lbs generated	$.982

Table III—Purchased power costs, in-plant charges added

Power cost, per kw-hr, at meters	$.01
Operating labor	.0005
Maintenance labor	.001
Overhead	.0015
Materials and supplies	.0005
Fixed charges	.0015
Cost per kw-hr, distributed	$.0150

Table IV—Generated power costs showing the cost breakdown

Steam costs, per kw-hr	$.01
Operating labor	.0004
Maintenance labor	.0002
Overhead	.0006
Materials	.00014
Fixed charges	.0014
Internal power	.0014
Cost per kw-hr generated	.01414

Gillette Practices Heat Conservation, Gains Surprising Benefits

Reflecting a rare combination of desire, initiative, ingenuity and imagination, plus a great deal of knowledge, know-how and elbow grease, this power plant has an over-all thermal efficiency of up to 82 per cent, produces electricity at a cost of under five mills

Editor's Note: This is one of a series of articles in POWER ENGINEERING on the importance of the conservation of utilities. These articles describe successful and outstanding efforts of power engineers in the conservation of heat, water, refrigeration, air, waste and other utilities. In the present article, the author describes what we believe to be one of the outstanding examples of heat conservation in the country. If your plant practices unusual measures in utility conservation, would you write the editors a note describing them?

By E. E. KIMBALL *

WITH THE THOUGHT constantly in mind that we are duty-bound to use to the greatest extent possible the heat content of the fuel we buy, we have devoted a great deal of time and effort during the past few years to doing just that.

The results have been remarkable. We have achieved a heat-utilization rate which runs, on the average, between 80 and 82 per cent. We are generating most of our own electricity, and at a cost well under five mills per kwh, for our diesel generator.

Generating equipment in our plant consists of a 1500-kw generator driven by a low-pressure (185-psig) condensing turbine, with 6-psig extraction, and a 1360-kw, 13,800-volt generator, driven at 720 rpm by a 1970-hp opposed-piston diesel engine. We operate tied in with the local utility, which, of course, controls our frequency. Reverse-current relays open our breakers in the event of a system outage.

It is around the diesel engine, affectionately known as "Whispering Lucy", that we have initiated many of the unique features of our plant. Because the engine is installed on the second floor of the power house, we chose the opposed-piston design to minimize vibration and total weight. This has proved to be satisfactory.

Fuel for this engine is reclaimed crankcase oil, which we buy in truckload lots from several suppliers at 6½ cents per gal. Handling of this fuel is in accordance with Fig. 1. It is received into a 55,000-gal. insulated tank, where it is stored at a temperature of 160 to 180 F. A minimum of 30,000 gal. is kept on hand.

From the tank the oil is pumped through a floating suction to a heater, where low-pressure steam assures that its temperature is 180 F for entry into a 300-gal. tank, from where it can be pumped to our process.

Processing Crankcase Oil

When the diesel engine was put into service, crankcase oil which had been passed through a centrifuge was used as fuel. It was soon discovered that the wear rate on the engine cylinders and other parts was abnormally high. This condition prompted an investigation into the quality of this fuel and it was found that, even though the crankcase oil was carefully centrifuged, the ash content averaged 0.5 per cent. Before centrifuging, the oil averaged 1.0 per cent ash, so it was apparent that only the suspended particles were being removed and that there still remained sufficient ash particles in solution to cause considerable concern.

Several attempts were made to remove this residual ash, or even lower it to an acceptable value. Finally, a process developed by the Barclay Oil Processing Co, proved to yield a finished product of very low ash content and one acceptable in all other respects.

Processed crankcase oil from this process has the following average values:

Flash point	360 F
Viscosity at 210 F	45
Viscosity index	120
Sulphur	0.4%
Ash content	0.01% max

The cost of processing the oil is approximately one-and-one-half cents ($0.015) per gal. This includes the chemicals, sludge loss, heat, labor, and all other expenses and losses.

Raw crankcase oil is taken to the cone tank, which is provided with a suitable mixer and holds 5000 gal. Here Additive No. 1 is added and thoroughly mixed with the oil, which results in a separation and dropping out of solution of most of the undesirable solids (ash).

After a period of settling, this material is drawn off at the bottom into a small tank. This amounts to approximately 100 gal of heavy residue, which along with the fall-out from the second mixing tank, is pumped

* Chief Engineer, The Gillette Safety Razor Co

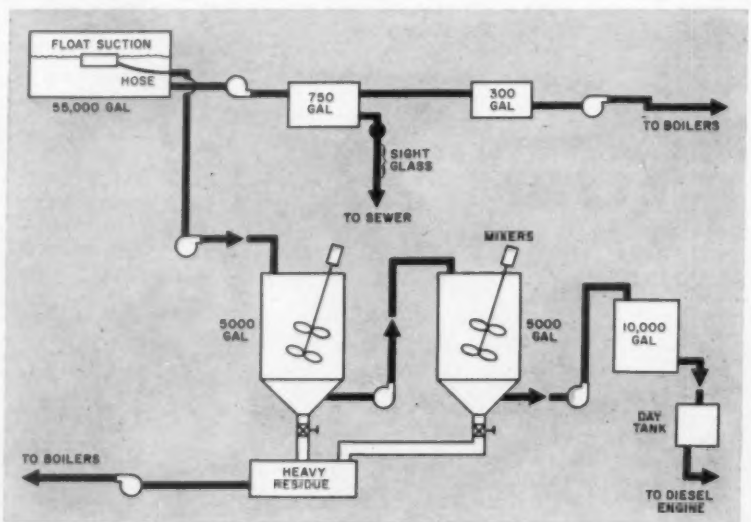


Fig. 1. Flow diagram of system for using reclaimed crankcase oil as diesel fuel

to the boiler house and burned under one of the boilers.

The partially-treated oil is then pumped into the next tank and Additive No. 2 is thoroughly mixed. This results in the removal of the balance of the undesirable material, which is allowed to settle and then is drawn off into the waste tank as mentioned.

The final processed oil, now containing less than one hundredth of one per cent ash, is transferred to a storage tank, thence to the day tank, and finally to the engine itself.

Every 5000 gal. lot is tested before it is pumped into our 10,000 gal storage tank, for ash content, flash point, burning point and neutralization number. Other analyses are made for us at regular intervals by our lube-oil supplier.

Its heat content is 143,000 Btu per gal., which is somewhat better than No. 2 fuel oil (137,000 Btu per gal.). So satisfactory has it been that our liner wear rate is lower than normal, according to the engine manufacturer.

It is necessary to control the quality of our reclaimed oil purchases very carefully, and for this purpose the cooperation of the suppliers must be required. We generally do not accept shipments containing over one per cent impurities, sludge, or water. While this has led to difficulties occasionally, this quality requirement now seems to be accepted by all our suppliers.

As shown in Fig. 1, there are several alternates and cross-connections in the flow diagram. Oil from the bottom of the storage tank, containing a somewhat higher amount of ash, is burned in the center burner of our No. 4 boiler.

We make every effort to use all available heat, not only in the power house, but also throughout the entire plant. This has resulted in the saving of thousands of dollars worth of fuel over the last few years. Fig. 3 is a diagram of our heat recovery system used in connection with the diesel generator.

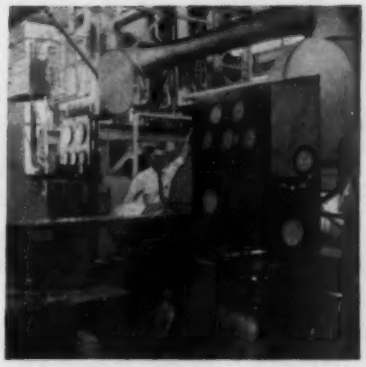


Fig. 2. Author with 50-ton jet refrigeration unit. Diesel engine is to left

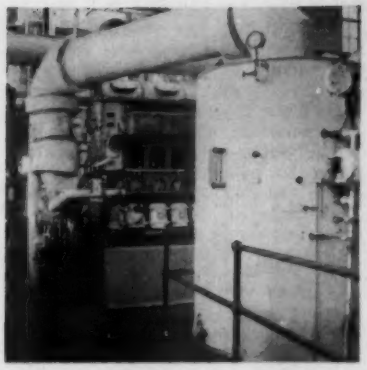


Fig. 3. Waste-heat boiler, with crossover from dual-exhausts in background

Maximum variation in our incoming city water is from 45 F to 75 F. After passing through the meter, it is passed through a heat exchanger where it collects the heat from the aftercooler, the intercooler, and the water jacket of our large air compressor (rated at 1000 cfm, 125 psig). It then passes through the engine lube-oil cooler, and the engine water-jacket heat exchanger.

From this point it supplies the water for domestic hot water, used throughout the plant. There is, as shown, an alternate source from which this water may be taken.

Temperature of the water after passing through these various heat exchangers is automatically kept at 150 F, and it generally has a pressure of about 40 psig. Passing through the boiler feed pump for the waste-heat boiler, it goes through our home-made economizer, where its temperature is raised to 228 F.

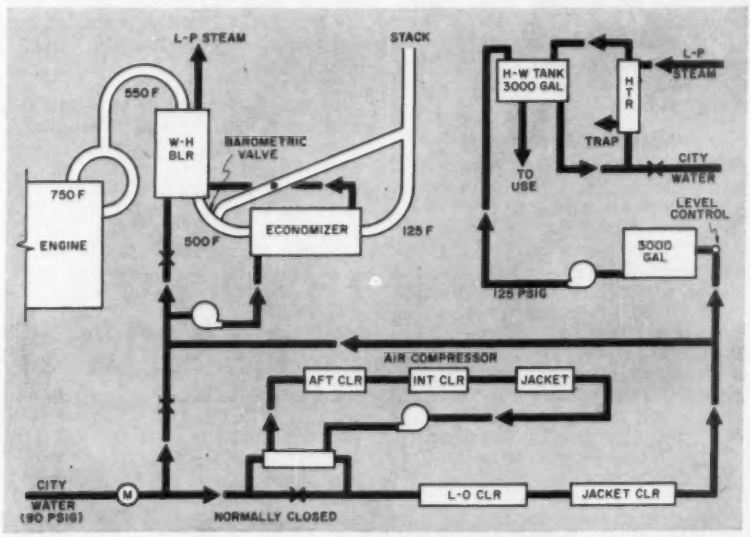


Fig. 4. Flow diagram showing methods of heat conservation and recovery in system

Operation Bootstrap

This economizer, which is probably the most important heat-recovery unit in our plant, is the product of considerable thought and experimentation. It consists of a large cylindrical tank which we were able to salvage from other plant operations, and 2400 ft of 1-in. copper tubing, separately requisitioned.

This copper tubing was placed inside the tank in the same spiral conformation in which it was delivered. Ten racks, each holding four 60-ft coils of tubing, were fabricated, fitted with the tubing, and installed in the tank.

We call this tank and its use as an effective heat exchanger "Operation Bootstrap", for obvious reasons. We conceded before we started that we would be unable to sell management on such a large and unconventional budget item as a commercial heat exchanger of this capacity would have been.

Left to prove the value of the system to ourselves and all concerned, we were able to construct and put it into operation using available time and materials.

Sometimes it is necessary for the power engineer to use a combination of faith, ingenuity, and elbow grease to get his job done in the best way possible. We are now assured of the necessary funds for the replacement of the exchanger when it becomes necessary. To date, however, it is operating well and with no maintenance.

Exhaust gases come off the cylinders of the diesel at about 750 F. Quickly cooling to 550 F, they are piped through the waste-heat boiler, which has a capacity of 10,000 lb per hr, and are cooled to about 500 F.

In passing through the home-made economizer, the exhaust is lowered in temperature to approximately 125 F, then passes to the atmosphere through a steel stack. Neither the stack, now three years old, nor the tank show excessive corrosion. While

this is very encouraging, it is well to remember that the savings effected by lowering the stack-gas temperature to this extent could well pay for at least a stack every year or two.

In order to prevent any excessive back pressure, which could conceivably interfere with engine operation, there is a by-pass of the economizer controlled by a barometric valve. This damper does not ordinarily open, but would in the event of a soot build-up in the economizer.

Uses for Salvaged Heat

Obviously, there would be little advantage in making the effort and investment necessary to save heat unless there were a good, year-round use for it. Fortunately we are able to employ this 6-lb steam produced by the waste-heat boiler in a number of process and building-heating applications. We also have a large demand for hot water, and a heavy air-conditioning load, each of which is taken care of by low-pressure steam. Thus we are able to profitably absorb this surplus heat energy 12 months of the year.

This provides a direct relief for the four boilers we operate, which have a total capacity of approximately 100,000 lb per hr. We are therefore completely justified in crediting to the electric generation account the cost of the waste-heat steam at a rate equal to the cost of steam in our boiler plant, which is $1.00 per 1000 lb.

During the average month we may consume something over 40,000 gal. of reclaimed crankcase oil in the generation of our electricity. In addition to this, lube oil runs about 170 gal. Total generation is well over 500,000 kwh.

After taking into account all station power, both electric and steam auxiliaries, space charges, depreciation, labor and material for maintenance, and supervision, our cost of generation is less than a cent per kwh. However, when we credit the heat recovered, we are able to substantiate a kwh cost of less than five mills.

Nothing is being done in our plant, of course, that cannot and should not be done in many plants throughout the country. While there is an obvious limit to the supply of usable reclaimed crankcase oil, the principles of heat conservation and recovery which we employ are sound, and should be much more widely adapted.

Much discussion in this country and throughout the world is devoted to the conservation of our natural resources. As long as we continue to send over half of the heat energy which we buy into the atmosphere, we certainly can't be taking this problem too seriously. THE END

Mach-20 Wind Tunnel Powered By 1,000,000-Amp Arc

Unique equipment includes an induction coil with 90-sq-in. conductors, a 1,000,000-amp disconnect switch, both probably world records, 47-ton flywheels, and unusual control and protection systems

A DIRECT-CURRENT arc of a million amps at 20,000 will power a new hypersonic "hot shot" wind tunnel at the U. S. Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.

Power supply includes motors, flywheel-driven d-c generators, a gigantic inductance coil, a 1,000,000-amp disconnect switch, a novel protective system and remote controls. The whole facility is scheduled to be finished and turned over to the Air Force in November, 1959.

Tunnel is designed to achieve air speeds up to Mach 20 (20 times the speed of sound). Air speeds of this magnitude cannot be sustained for more than a tiny fraction of a second, but this is long enough for testing purposes. The tunnel will be the nation's first hypersonic tunnel big enough to take full-sized nose cones, missiles, and rocket components.

Tunnel will work on the principle of heating compressed air in a small vessel by a high-intensity d-c arc. The air, at great heat and pressure bursts a frangible diaphragm and expands through a nozzle carefully designed to let it accelerate smoothly to hypersonic speeds in the test section and then come to rest in a large vacuum chamber.

Power for the arc is supplied by a two-stage energy-storage system devised by engineers of General Electric's Industrial Engineering Section. G-E will furnish all equipment.

Energy drawn from the AEDC's 6.6-kv electrical system for 15 to 30 min is first stored in flywheels. Some 70 per cent of the flywheels' energy is then drained off in six to eight seconds to drive d-c generators that charge the induction coil and store energy in its magnetic field. When the field is fully charged, the arc circuit is switched on. Stored energy in the magnetic field produces the arc current, 1,000,000 amp at 20,000 v, discharged in 1/100 of a second.

System will be able to repeat the cycle every half hour. Total amount of energy delivered in each pulse is not great: about 42 cents worth of electricity (at average retail rates). Only 2,500 kva will be drawn from AEDC's electrical system, but the power will be boosted and the time shortened at each successive stage of energy storage.

Electrical Equipment

Two ordinary squirrel cage induction motors rated 1,000 hp each will drive the two flywheels through eddy-current clutches. Each flywheel will be 76 in. in diameter, 64 in. thick, and weigh 47 tons. It will take the motors about 15 min at 33 per cent overload to bring the flywheels up from zero speed to 1800 rpm, when they will be storing about 650,000,000 watt-seconds of energy. In subsequent operations the motors will "loaf" at partial load and take about 30 min to bring the flywheels up to speed.

The flywheels will be coupled to two d-c generators rated 550,000 amp, 45 v.

An air-core induction coil, believed to be the largest ever built (11 ft in diameter, five ft high and weighing about 60 tons), will be braced to withstand a clamping force of 12,000,000 lb at its mid-point. The enormous magnetic field created by the current through the coil tends to squeeze it like compressing a spring. It will be located in its own wooden enclosure, with no iron or steel within 30 ft of it.

Coil's stranded-copper conductors will have a cross-section area of 90 sq in., capable of carrying 1,000,000 amp of current. Energy stored in the magnetic field after 6½ sec of charging will total 121,000,000 joules, and the flux density at the center of the coil will be approximately 500,000 lines per sq in.

Switches and protection system are being specially designed to handle the unusually-high current. A remotely-operated pneumatic-powered disconnect will probably qualify as the world's largest switch. Capable of carrying 1,000,000 amp for ¼ of a sec, it will serve as an isolating device, not for operation under load.

A precision spark gap and automatic shorting switch will protect the coil insulation from overvoltage. The gap insulation will break down below the dangerous voltage level and the resulting flow of current will automatically close contacts connected in parallel with the gap. Without these shorting contacts it is estimated the arc would melt 450 lb of copper before the coil's energy was dissipated.

Integrated controls for the whole power supply system will use four amplidyne regulators and special relaying and sequencing circuits.

Consider Silicon Rectifiers for General-Purpose D-C Power

In the power field, dependable sources of direct-current are a common problem. New semi-conductor, Silicon, appears to be the answer for rectifier design. Absence of maintenance, added to economical operation, make this new source of power interesting

By W. L. OVERSTREET *

INDUSTRY'S DEMAND for a dependable, highly efficient, and inexpensive general-purpose power supply is finally being met by an equipment incorporating the fabulous semi-conductor — silicon. The continued growth of d-c power requirements for cranes, machine tools, elevators, variable speed drives, and accurate line speed controls requires the utmost in ac-dc conversion efficiency and dependability in the conversion media. Silicon enables the manufacturer to design and economically produce near perfect a-c to d-c conversion equipment in small or large blocks up to 2,000 kw. Semiconductor rectifier installations totaling more than 100,000 kw, in more than 200 single locations, are proving this type of rectifier to be a dependable industrial equipment — when properly designed and applied.

Most of this installation experience has been in germanium rectifier equipment. However, the silicon rectifier has proved by installation experience to be practically identical — as far as design problems, operating characteristics, and dependability are concerned. As a matter of fact, the higher operating rectifier junction temperatures permissible with silicon will somewhat alleviate the cooling problem for the manufacturer.

For the purposes of this article, let us confine ourselves to general-purpose, 125 v and 250 v d-c power supplies. While silicon rectifiers have obvious advantages at d-c voltages ranging from 6 v for plating applications, all the way up to 800 v for aluminum pot-line and electrochemical applications, there are fundamental differences in the design approach for equipment for these applications which shall not be detailed here.

Next to dependability of operation, probably one of the more important considerations in the selection of a d-c power supply is the efficiency of conversion. Let us take a look at the well-designed silicon rectifier from this standpoint. Fig. 2 shows typical efficiency for several types of conversion equipment. A quick glance shows the obvious advantage of the silicon equipment. Silicon equipment efficiency of 95 per cent, from one-quarter load through 100 per cent load, is a very attractive feature. Of course, the larger the rectifier installation, the more attractive this feature will be to the user.

Silicon's Advantages

One of the more common objections to *selenium* rectifiers for large d-c power blocks has been the gradual increase in forward resistance of the selenium rectifier element. This phenomenon is generally referred to as "aging." This change in characteristic usually requires that the selenium elements in the equipment be replaced after five to eight years of operation. *Silicon* has not displayed this "aging" characteristic. This, obviously, indicates an appreciable decrease in maintenance expense over a period of many years. Further, the non-aging characteristic of silicon will insure that the high efficiency of the equipment will not deteriorate.

Voltage regulation from no-load to full-load often becomes an important consideration to the user. Silicon rectifier equipment is available with a no-load to full-load voltage regulation of 8 per cent or less. A quick glance at Fig. 3 reveals a very distinct improvement over the average selenium rectifier. Usually, 8 per cent voltage regulation should be satisfactory for most applications. However, the equipment purchaser must remember that if he has a-c voltage fluctuations, these voltage changes will also be reflected in his d-c voltage output. In cases where the 8 per cent inherent regulation, and a-c line voltage fluctuations, may give undesirable d-c voltage changes, then a voltage regulator can be utilized to offer a packaged d-c power supply, with the d-c voltage regulated to within plus or minus 1 per cent. By simply adding additional range and KVA capacity to the regulator, it is also economical to obtain a regulated d-c output which can be manually adjusted over as wide a range as desired.

If properly designed with suitable protective features and overload capacity, the silicon rectifier equipment can be made completely self-protected, or nearly foolproof. A method of providing this self-protection is to include an a-c circuit-breaker of the proper interrupting capacity for the application, undervoltage device, dual magnetic trips, an extremely inverse-time-delay relay (with instantaneous attachment), and fast-acting fuses for the silicon cells. The equipment must have enough silicon cell, and fuse, capacity to carry full (bolted) d-c short-circuit current for about five cycles. This gives adequate time for the instantaneous overcurrent relay to activate the a-c breaker under-voltage trip, and shut

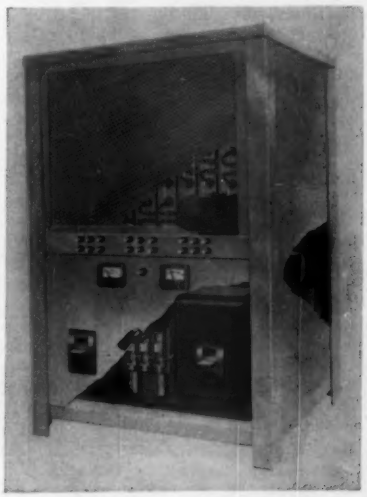


Fig. 1. Packaged-type silicon rectifier unit, with transformer and switchgear

* General Electric Company, Lynchburg, Va.

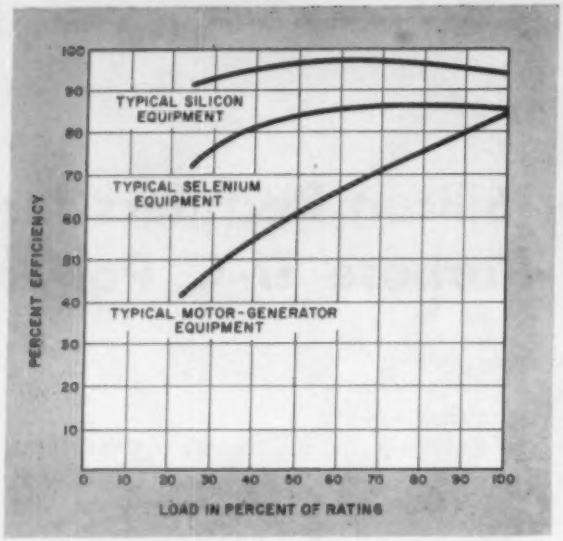


Fig. 2. Curves depicting the per cent efficiency of silicon, selenium rectifiers, and motor-generator conversion equipment

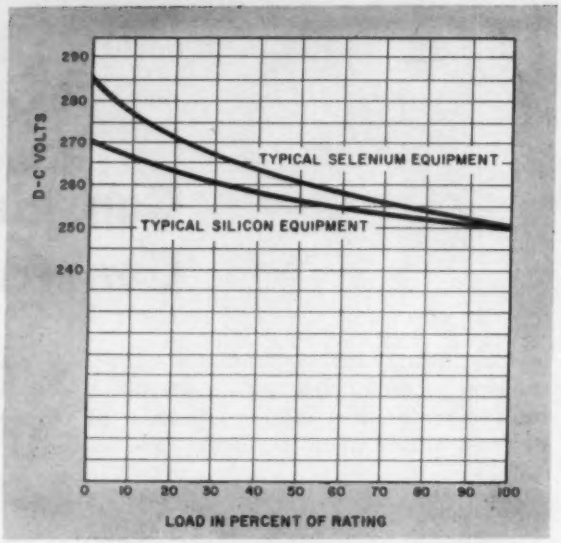


Fig. 3. These curves illustrate improved voltage regulation from silicon rectifiers, over that obtainable from selenium

the equipment down prior to any silicon cell (or fuse) damage. After the fault condition has been corrected, reclosure of the a-c breaker will put the equipment back in service, without costly and time-consuming silicon cell or fuse replacement. In large installations, where a-c line voltages of 2300 and up are utilized, a common practice is to utilize primary a-c fuses, and to include a d-c breaker, to provide the functions indicated for the a-c breaker.

This self-protected feature described above will automatically assure enough silicon cell and fuse capacity to economically give the usual recommended rating of 100 per cent continuous, 125 per cent for two hours, and 200 per cent for one minute. It would be well to point out here that a fast-acting fuse is usually inserted in series with every string of silicon devices. This is to prevent properly-performing silicon devices from feeding excessive current into an internal short circuit, caused by the failure of the silicon devices in one of the series strings. These fast-acting fuses are selected with characteristics closely approximating the failure point of the silicon devices.

Great strides have been made in the technology of silicon cell manufacturing techniques, and experience indicates that silicon cell failures should be very rare. This very low failure rate, being the only significant cause of maintenance in a well-designed silicon rectifier equipment, makes this equipment highly desirable from a maintenance standpoint. However, many applications for this class of equipment require a high degree of dependability from the continuity-of-service standpoint. Consequently, another feature is incorporated in the equipment. There s a counting-type fuse monitor which ndicates visibly and audibly when one string of silicon cells has failed.

Above recommended overload capacity, when a suitable number of parallel silicon elements are utilized, will enable continued full-load operation of the equipment even after one cell has failed. The counting fuse monitor will shut the equipment down only after the failure of a second string of silicon cells, which is in parallel with the first. Such a shutdown should be extremely rare.

Requirements Met

Silicon rectifier equipment is available to meet all of the above requirements, in ratings from 75 kw through 2000 kw, at 250 volts dc. From 75 through 300 kw the equipment is usually built as a single unit, with transformer for a-c primary voltages below 600 v, switchgear, silicon cells and all the protective equipment — housed in one metal enclosed cubicle, as shown in Fig. 1. Matched and lined up, fully-integrated systems (d-c unit substation equipment) begin at 250 kw and extend to 2000 kw. These d-c unit substations are designed with non-flammable, liquid-filled transformers, having primary voltage ratings from 2300 v through 14,000 v ac. Fig. 4 shows a typical d-c unit substation.

The silicon rectifier units described above will usually offer the user the most desirable package available in sizes up to 300 kw. For 300 kw and larger installations, the silicon substation supplements the existing, and long field-tested, mercury-arc rectifier; the user should investigate both types of equipment for the one most suitable for his needs. THE END

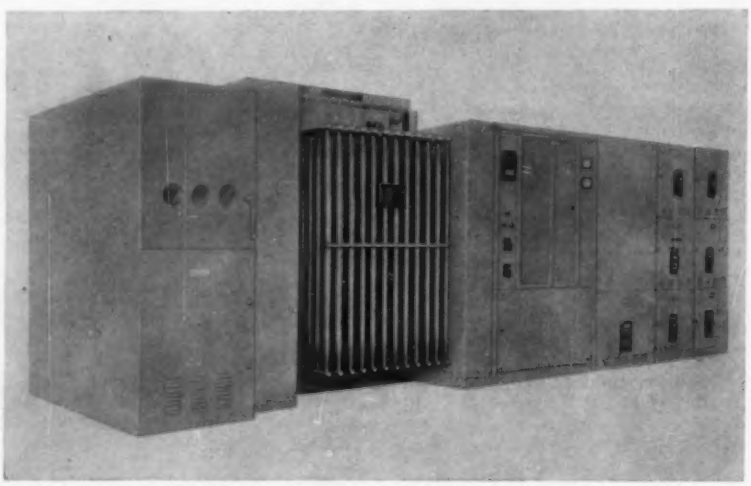


Fig. 4. Typical integrated, silicon rectifier unit-substation equipment. It is sized from 250 to 2000 kw, and primary voltage ratings are 2300 to 14,000 ac

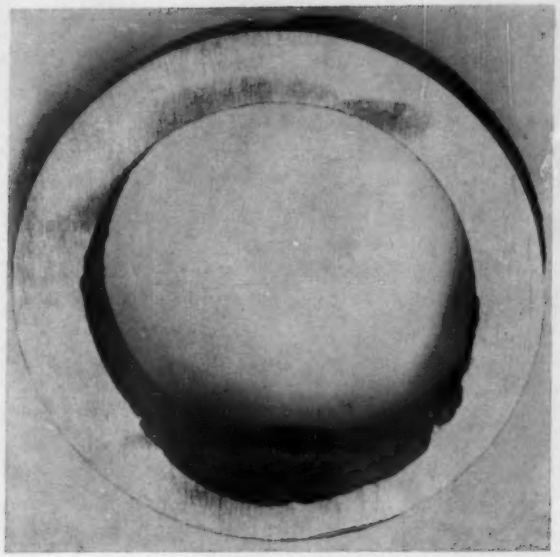


Fig. 1. Oxide deposit in boiler tube so closely bonded to tube surface that boiler water never touches tube metal

Tube failures in modern central station boilers frequently result from spontaneous growths of iron oxide in regions of high heat transfer. Modifying boiler water chemistry does not appear to be the answer to all such types of tube failures

THERMIATRICS: Study of the Diseases Of High Temperature Boilers

By **DOUGLAS E. NOLL** *

IN THE MEDICAL SCIENCES there is a subdivision called *geriatrics* which is concerned with the diseases of old age in humans. In the title of this discussion there appears a coined word, *thermiatrics*, which we define as the study of the afflictions of boilers operating at high temperatures. We don't pretend that this word will become a permanent part of the English vocabulary, but we will use it here because its analogy to geriatrics will introduce our subject.

Term *high temperature* is used advisedly because it is the factor that is particularly significant in most of the developments that lead to tube failures in high pressure, central station boilers. We frequently describe boilers by referring to their pressures, probably because our attention is always attracted by a conspicuous pressure gauge when we walk into a boiler house, but temperature, which is the consequence of pressure, is the real culprit in this era of steadily increasing pressure as reported recently before ASME.

Not too long ago the greatest enemies of human life were infectious diseases such as measles and typhoid fever. Now that the fruits of medical research have nearly eliminated them as threats to life, man is living longer. As a result he is afflicted with diseases that formerly did not manifest themselves in the shorter span of life then allotted to him. These diseases, though not unknown in former years, have taken on sufficient added importance that their study now constitutes a separate branch of medicine.

Similarly, the role that heat plays in tube failures is not a new one. It is merely more important than it was when failures could be diagnosed as the result of the insulating effect of deposits or the concentration of boiler water beneath them. Improved technology in the field of water conditioning has virtually eliminated the distress resulting from deposits of sludge and scale containing elements that enter with the makeup. Modern techniques for treating condensate have certainly diminished the role that deposits of corrosion products play in the development of failures. We see that relentless progress has relegated many of the boiler difficulties of the past to the category of measles and typhoid fever.

Oxide: Hardening of Arteries

Diseases normally associated with old age are, of course, cancer and circulatory ailments. Diseases of high temperature boilers are those associated with the formation of iron oxide in areas of high heat transfer. Our analogy is particularly apt here because surgery often provides the best solution in both instances. Rather than belabor this comparison further let us leave geriatrics to the medical profession and confine our discussion to thermiatrics.

Figure 1 shows an example of boiler tube cancer in an area of high temperature. The hard, dense deposit is 98 per cent magnetic iron oxide. Spectrographic examination revealed no evidence of copper, which we would expect to find had the source of the deposit been condensate corrosion products. Interface between the deposit and the base metal does not correspond to the original surface of the tube. Rather, the oxide occupies space once taken up by the metal. When the deposit, which was very tightly bonded to the tube, was removed, the exposed surface of the metal had a gouged appearance. It resembled that frequently associated with caustic attack.

Of course, there are many examples of bona fide caustic attack resulting from the development of extreme sodium hydroxide concentrations beneath porous deposits or on surfaces subject to heat fluxes far beyond design ratings. However, when the concentration of caustic is great enough to dissolve the iron oxide film that normally protects the tube metal from the action of boiler water, re-precipitation occurs at some distance from the point of attack where the water is less alkaline. There appears to be no mechanism that reconciles the action of concentrated caustic with the extremely dense deposit, Fig. 1, formed in place.

Figure 2 reveals oxide phase was in such intimate contact with the remaining metal that there was no room for boiler water to seep between the oxide and the metal. Having excluded the feedwater system as the source of the oxide and having discounted chemical attack to account for the conversion of the tube metal to oxide, we are now obligated to provide some explanation for the

* Hall Laboratories Div of Hagan Chemicals & Controls, Inc

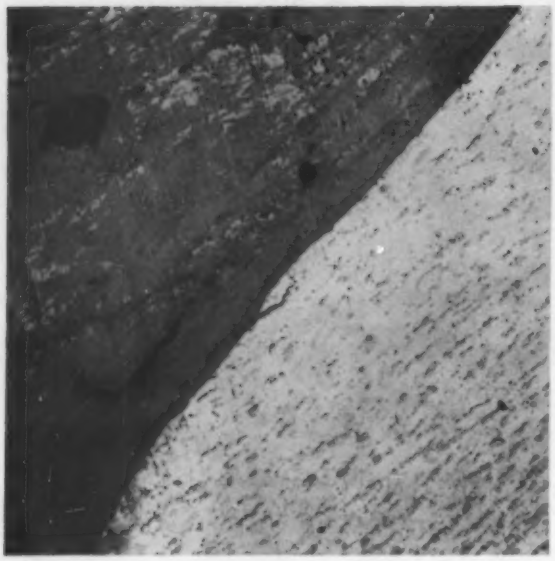


Fig. 2. Photomicrograph (40x) of metal-oxide interface of sample in Fig. 1. More than water treatment is needed here

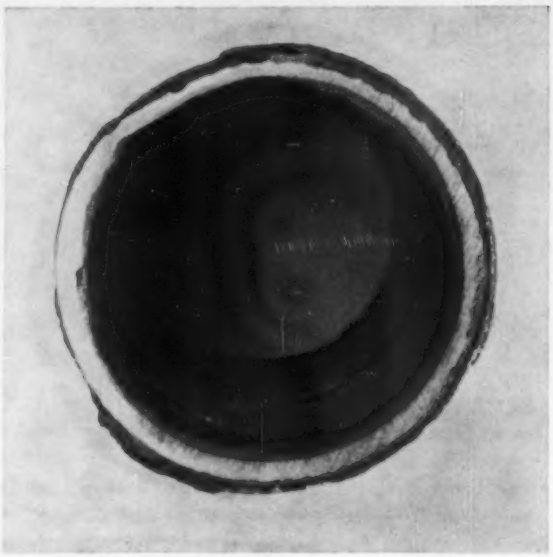


Fig. 3. This photo shows uniform layers of magnetic iron oxide deposited on both surfaces of a boiler tube in trouble

deposit shown in Fig. 1, one that ignores the chemistry of the boiler water and takes into account the fact that the boiler water was not even in contact with the metal. Such an explanation is not at all farfetched.

Deterioration By Metalignancy

Let us shift our attention to a generating tube in a modern high pressure boiler. Between the furnace gases and the bulk of the boiler water, there is a temperature difference on the order of 2000 F which produces a flow of heat through the tube wall. After the boiler is put in operation and the oxide layer begins to grow, the share of the temperature drop taken by the oxide must steadily increase with a corresponding increase in the temperature of the tube metal.

Hotter the metal becomes, the faster it will build upon the oxide layer on its inner surface in contact with the steam-water mixture as well as upon that on its outer surface in contact with the furnace gases. Figure 3 is a section of boiler tube that has suffered such a fate. Because the tube failed, the progressive increase in temperature of the steel caused by the growth of the insulating layer of oxide on the internal surface obviously speeded up the diffusion more than it was slowed down by a lengthening diffusion path.

Fortunately the hardening of the arteries shown in Fig. 3 is an exceptional disease rather than a common one. Except for a few critical locations in a relatively small percentage of high pressure boilers, the oxide film on the inner surface of the tubes apparently remains a more effective barrier to the migration of iron than it is to heat transfer. Those extreme cases of overheating which result in metal creep, regardless of conditions on the inner surface of the tubes, are outside our immediate sphere of interest. It is the critical range of temperature generally not exceeding 1000 F that requires our attention. It would certainly be a great stride forward if it were possible to define the conditions that cause the oxidation process to "go critical." We need to know much more than we do about the relationship between rate of heat input and metal temperature on the one hand and between temperature and rate of growth of oxide on the other. We need to know why oxidation in the tube shown in Fig. 1 occurred at a local spot on the inner surface only while oxidation proceeded uniformly over large areas of both surfaces of the tube in Fig. 3.

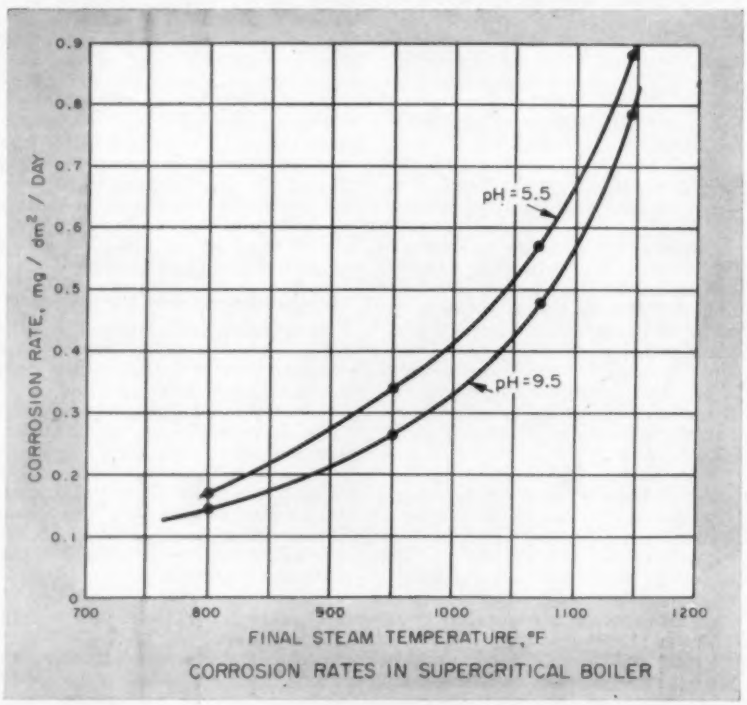


Fig. 4. This graph shows corrosion rates in supercritical boilers related to pH

Presently we are not without evidence that the diffusion of iron through the oxide film controls the rate of oxidation in a real boiler. In determining the operating characteristics of an experimental supercritical steam generator, it was found that the only significant factor that could be correlated with the rate of oxidation within the unit was steam temperature. Corrosion rates calculated from the hydrogen concentration in the steam and the rate of blowdown remained virtually the same whether the pH of the feedwater was adjusted to 9.5 with ammonia or whether it was untreated. PH measurements were difficult to make on the pure, unbuffered feedwater, but it was determined that the pH was in the neighborhood of 5.5 when ammonia was not fed, the unusually low value being attributed to an organic contaminant in the makeup.

Data, reduced to corrosion rates, are shown in Fig. 4. Obviously, if the evolution of hydrogen in the boiler had been the result of the reaction of water and steel at the metal surface, the corrosion rates would have been much greater at low pH. Unfortunately, data were not collected over a long enough period to determine whether or not oxidation diminished with time as the oxide grew thicker.

Fact that the data were taken from a supercritical unit does not mean that those of us interested in the performance of subcritical boilers should feel the results have no meaning. Indications are that the diffusion of iron controls the oxidation process above about 400 F, which takes in boilers in the low to intermediate pressure range.

Prescription and The Cure

Now you may ask, "Does the knowledge of the diffusion of iron change our prescription for combating the ailments of high temperature boilers?" The answer is no for troubles of the measle variety, by which is meant, for example, failures at welds, overheating beneath deposits that have settled out, and attack on tube metal beneath porous deposits.

Lest someone have uneasy feelings that the stage is being readied for the final bow of the water chemist, it is well to remember that these difficulties frequently respond to modification of chemical treatment. It is clearly the responsibility of the chemist to prescribe the treatment that best counteracts the influence of localized stress and accumulations of deposits. On the other hand, where there are indications of the spontaneous growth of iron oxide owing to the effect of heat alone, a change in emphasis away from boiler water chemistry is in order.

Currently there are three chemical prescriptions that the operator of natural and controlled circulation boilers can follow. The first is the maintenance in the boiler water of a low, controlled residual of sodium hydroxide and just enough phosphate to insure against scale formation in the event of a condenser leak. The second does not use any sodium hydroxide, but calls for the use of enough trisodium phosphate to produce a pH near 11.0. The third advocates essentially pure water with only enough of a volatile alkali added to maintain a condensate pH around 9.0. If contact between the boiler water and the tube metal is prevented by a thin, continuous layer of magnetic iron oxide, we would not expect any of these prescriptions to be a guarantee against tube failures. And, of course, none is, as we know that failures have occurred under all three systems in especially hot areas of boilers.

Where, then, can we turn to meet this challenge that higher and higher temperatures have brought us? We can always acid-clean our boilers before the oxide has grown thick enough to be a significant barrier to heat transfer.

Although the economic spacing of outages for such cleaning requires a clairvoyance that few of us possess, it remains a practical answer to some types of tube failures. In the future, as outages become more and most costly, the challenge will doubtless be met by metals more resistant than carbon steel or by better distribution of heat to the absorbing surfaces to avoid "hot spots". THE END

New Easy Way to Find Right Fuel Oil Temperature

PROBLEM OF DETERMINING proper degree of preheat at which to burn the heavier grades of residual fuel oil has long plagued operators of oil-fired plants. A new calculator-indicator recently made available to industry promises to go a long way toward solving the problem.

Burning of No. 6 fuel oil for maximum efficiency requires accurate regulation of preheat. If the oil is burned below optimum temperature, atomization is not good, smoke becomes a problem, and quantities of unburned oil escape the furnace to deposit on air heater surfaces as soot. If oil is burned at a temperature above the optimum, heating steam is wasted and heating value of the oil is diminished. Problem is aggravated in smaller plants having limited fuel storage capacity due to necessity of blending deliveries with dissimilar characteristics.

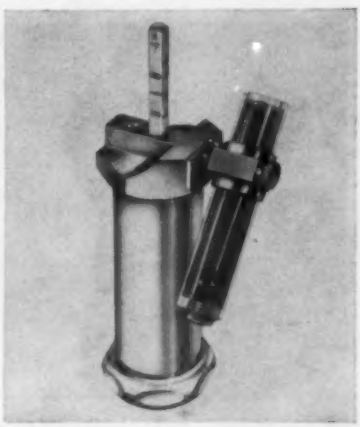
Instrument recently introduced is called a fuel oil preheat indicator. It directly indicates temperature to which No. 6 oil must be preheated for best atomization viscosity. The instrument is easy to use, even by inexperienced personnel. No timing, calculating, or reference to charts is needed, since the instrument's operational mode is entirely mechanical.

Instrument consists of a stainless steel cylinder as the container for a sample of the oil to be tested, a steel scale-rod having a piston at its lower end which is precision-fitted into the cylinder, and a "falling ball" timer comprising a ball sealed in a fluid-filled transparent tube.

Procedure Is Simple

After pouring four ounces of fuel oil into the instrument's cylinder, its top cap is replaced with the scale rod pulled up to the zero mark. The falling ball timer is then swiveled clockwise. This releases the scale-rod, permitting the piston at its lower end to sink through the fuel oil in the cylinder while the ball falls through the fluid column in the timer tube. Weight of the ball passing the timer's fulcrum causes the timer to swivel automatically and to actuate a lock which stops the piston's travel through the fuel oil in the cylinder. Preheat temperature required for the fuel oil tested can now be read directly on the scale engraved on the scale rod. Scale is for mechanical pressure-atomizing burners firing No. 6 fuel oil ranging from 70 to 215 Saybolt Seconds Furol viscosity at 122 F. This covers the full range

If you would like more information about this application, drop a line to the editors or jot Fuel Oil Preheat Indicator on one of the inquiry cards located in the back of this issue.



New fuel oil preheat indicator developed to assist operators in determining optimum temperature for combustion

Fig. 1. At session on Industrial Electrical problems: l to r, I. Rosenak, A. Swatek, both of Inland Steel Co; M. A. Jacobs, A-C Spark Plug; N. Cutleff, International Harvester Co. Emphasis was on training for handling complex controls

Fig. 2. Four Russian engineers participated in Extra-High-Voltage Systems session: l to r, B. P. Lebedev; I. A. Siromiatnikov; V. V. Burgsdorf; L. Kudriavtsev; interviewed by Richard H. Morris, editorial director, POWER ENGINEERING

American Power Conference Looks Ahead To Great Power Field Future

DISCUSSIONS and papers at the 21st American Power Conference gave power engineers a pretty accurate idea of what the future of the power field will be like. It will be filled with challenges, and power engineers will meet them as they always have.

To discuss them, over 3000 of the nation's top power engineers, from electric utilities and from industrial plants, met at this conference in the Hotel Sherman, Chicago, March 31 to April 2. It is the only independent national conference devoted solely to the problems of power. It was sponsored by the Illinois Institute of Technology in coöperation with nine universities, five associated universities and nine national engineering societies. R. A. Budenholzer of IIT is conference director and E. R. Whitehead of IIT is conference secretary.

Latest Developments

Power field developments now under way, in which engineers must participate, include use of once-through super-critical and sub-critical steam generators, larger steam turbine generators, water treatment to meet more rigorous conditions, trend to higher electrical transmission voltages, new viewpoints on hydroelectric power, advances in fuel burning technology, control of equipment and systems by computers, new circuit breakers, considerations in operating and maintaining industrial power plants and steam plants, electric systems, electric space heating. There was much interest in a session on direct conversion of heat to power and on the details of thermonuclear fusion research for power. Present atomic power plants were also discussed. Running through all the discussions was the vital thread of economics and costs.

Addressing the All-Engineers' Dinner, Brig.-Gen. Herbert D. Vogel, of TVA pointed out that engineers must do even better to carry the burdens that will be imposed upon them. He stressed the three principles on which Thayer built West Point courses so effectively: probity, education, discipline. By discipline, he meant the inner discipline of the mind, a matter of morals.

Murray Joslin of Commonwealth Edison Co explained how we can meet the challenge of rising costs in the electric utility business. J. E. Corette, president of EEI and of Montana Power Co, emphasized the importance of the power industry, warned against the encroachment of Government on business and especially the power business, and said we must have less Government aid.

Charles L. Brown of the Air Preheater Corp, discussing the economics of air preheat on industrial boilers, presented data on a regenerative air preheater installed on a paper company's boiler designed to be fired either with fuel oil or pulverized coal.

Fig. 3. Murray Joslin, Commonwealth Edison Co, addressed opening conference session on Meeting the Challenge of Rising Costs in the Utility Business

Fig. 4. A. W. Kramer, editor Atomics section of POWER ENGINEERING, functioning as chairman of session on Long Range Goals for Power Generation

Fig. 5. In a packed session on Fuels, LeRoy F. Deming, head, Power Generation Section, Bureau of Yards & Docks, U. S. Navy, questions a speaker and offers cogent commentary on fuels

He explained how the performance was analyzed and gave detailed figures on fuel costs, operating costs, fixed charges and other data to show that the installation of the air preheater resulted in a fuel saving of 10 to 11 per cent. Including all the cost factors for different fuel prices, net savings ranged between $20,000 and $26,000 a year on an air preheater costing $34,000. This resulted in a payout time ranging between 1.64 years and 0.92 years, and a return on money ranging between 61.3 and 108.7 per cent.

Fuel Burning Equipment

Review of fuel burning equipment for industrial plants was given by A. W. Jackson of The Babcock & Wilcox Co. He gave details of a multispud gas burner designed to handle pulverized coal, oil or gas separately or in combination. He then reviewed the details of a jet ignition stoker, the Vibragrate stoker, the Rotograte stoker and the cyclone furnace, including a design for wood firing with the cyclone.

Maintenance of a power plant, said Kenneth R. Hodges of Sears, Roebuck and Co, requires careful planning, standard procedures for operation, maintenance and lubrication of equipment; proper organization of the maintenance force, proper records of equipment and maintenance, effective instruction and supervision, proper training of personnel and necessary tools and supplies. A panel of engineers from various industrial companies discussed these points and answered questions submitted by the audience relating to lubrication, installation of water walls in existing boilers, problems in dealing with management on maintenance costs, and similar problems.

Central Station Power Plants

Of great interest to the audience were the results of the second year of operation at Philo, the first supercritical unit in the country, as reported by Frankenberg, Lloyd and Morris of American Electric Power Service Corp. This plant has been completely described in many technical papers and periodicals, including POWER ENGINEERING.

A number of outages were reported; however, many were for inspection and were pre-planned when the unit was put into service.

One of the major difficulties was to determine the cause, and find a solution for, the deposition of copper deposits on turbine blading. This is apparently a carry-over of cuprous and cupric oxides from the steam generator, caused by super-critical steam pressures. Despite the problems encountered, the way has been paved for future designs of this type of unit, in even greater capacities

Evolution of automation in steam-electric generating plants was well covered in a paper by F. A. Ritchings and W. A. Summers, both of Ebasco Services, Inc. This paper tells logical development of scanning, logging and results computation, as the first steps in a fully-automated system.

C. D. Birget and J. H. Kline had a paper on power plant enclosures. Using conventional total-enclosure as a base, studies were made of semi-enclosed, total-outdoor, and outdoor above-grade designs. The plant in question was a two-unit project, totaling 530,000 kw. Conclusions reached: Savings in initial cost were $437,500 for a semi-outdoor design; $476,800 for outdoors; and $679,700 for the outdoor plant above grade.

Once-Through Boilers

Also of great interest to the Power Conference was the symposium on once-through boilers for subcritical pressure. Several features of this type installation commend it for incorporation in design of large capacity generating units of the future. Two very excellent papers were presented covering experience to date with two such installations, the Tait Station Unit No. 4 of Dayton Power and Light Co and Portland Generating Station of Metropolitan Edison Co. Both of these units will be covered in detail in an early issue of POWER ENGINEERING.

Pre-operational cleaning of the boilers was stressed in both papers for obvious reasons. Citric acid was the cleaning medium in both cases, for the purpose of eliminating concentrations of chloride that could attack stainless steel superheater piping, and for using the citric acid to chelate the iron and to keep it in solution as pH of the water was raised during the rinsing operation. More detailed account of this operation, at an early date will be published in POWER ENGINEERING.

E. H. Miller and B. M. Gain of G-E predict that the tandem compound steam turbine generators will

Fig. 6. Chester R. Earle, left, editor POWER ENGINEERING, talks with Glen B. Warren, G. E. vice president, ASME president (center); and J. H. Harlow, chief mech. engineer, Philadelphia Electric Co

Fig. 7. At joint APC-ASME luncheon, l to r, M V. Maxwell, chairman, Chicago section ASME; speaker, J. E. Corette, president EEI and Montana Power Co; Glenn B. Warren

Fig. 8. At Extra-High-Voltage Systems session, H. W. Haberl, Quebec Hydro-electric Commission, delivers paper on the 300-KV System. At right, Eric T. B. Gross of IIT, meeting chairman

Fig. 9. John R. C. Kelly, Jr, Westinghouse Research Laboratory, explains the principles, development and future possibilities of thermoelectric devices for direct conversion of heat into energy

Fig. 10. L to r, Julian E. Tobey, Appalachian Coals; Frank Weaver, Federal Power Commission; Francis L. Adams, Federal Power Commission, Jeff Hunnicutt, assoc. editor, POWER ENGINEERING

be extended to 400,000 kw and perhaps to 500,000 kw during the 1960's. Cross compound units may approach 1,000,000 kw. Initial pressure of 3500 psi, these experts say, will be most favorable at the larger ratings.

In the capacity range of 100,000 to 175,000 kw, Miller and Cain predict that the tandem-compound, double-flow reheat turbine, with either 23-in. or 26-in. last-stage buckets, will probably remain the popular choice.

Presenting a progress report on research and development, J. K. Dixon and G. W. Staats of Allis-Chalmers said that perhaps the most significant advance in materials has been in spindle and rotor forgings.

They also reported development of a 540-deg transposition of conductor strands for single-turn stator coils, a new configuration which decreases eddy-current loss in the stator coils, thereby reducing operating temperatures. A new hydrostatic thrust-type shaft seal has also been developed, which affords the advantages of reduced oil flow and lower friction loss.

H. R. Reese of Westinghouse predicted that, to meet tomorrow's demands for ever-larger blocks of power, the trend will change from large numbers of tandem-compound double and triple flow units to cross-compound sextuple and octuple flow units.

Hydroelectric Power

The meeting also marked a vital resurgence of interest in the field of hydroelectric power development. With frank acknowledgement of the many problems, primarily financial, that confront new development, there was a strong air of optimism about the two sessions devoted to the subject. As usual, strongest support came from the several Federal agencies concerned with generation, transmission and distribution of hydro power.

Ironically, the strongest case for added Federal development of new water power resources was made by those agencies to which actual generation of electric energy is distinctly a secondary objective to all others.

Brig.-Gen. John L. Person, U. S. Army Corps of Engineers, noted that about 20 per cent of all hydroelectric generating capacity in the United States is operated by the Corps of Engineers. This represents about 4 per cent of all capacity, both steam and hydro, now serving the electric utility industry and is the largest block of hydro capacity under any agency or organization in the country.

That power is secondary to considerations of navigation and flood control, continued Person, is attested by the fact that $3,800,000,000 spent by Corps of Engineers over a period of 16 years saved $9,000,000,000 in flood damage over a like period. A greater return on investment would be hard to conceive in any field of endeavor. Person concluded with an observation that an age is fast approaching when the importance of domestic water supply and the effective storage of it will transcend considerations of power, navigation and flood control.

In a paper prepared by W. A. Dexheimer, Commissioner of Reclamation, and delivered by Don S. Campbell, Chief of Power Division of that agency, it was stressed that generation of hydroelectric power is low man on the totem pole as far as priority of use of water is concerned on Bureau of Reclamation projects.

Commenting on the future of the generating medium, Dexheimer quoted from the January, 1959 issue of POWER ENGINEERING to make the observation that "For the future, I see a continuing development of hydro-electric power for the United States and for most foreign countries. A few countries will approach full development and the remaining less economically-attractive hydro sites will feel increased competition from thermal and nuclear sources.

Francis L. Adams, Chief of the Bureau of Power of the Federal Power Commission, reported that about 25 per cent of the estimated 118,000,000 kw of hydroelectric capacity in the U. S. has been developed. P. P. Stathas of Duff and Phelps, Inc filled in the picture further by estimating that the already developed hydro projects in the U. S. contribute about 22 per cent of the nation's electric energy requirements. There are some 29,000,000 kw of developed hydroelectric capacity, Stathas said.

Protection

Reviewing the history of insulation standardization and the development of lightning arresters for electrical equipment, H. R. Armstrong of Detroit Edison pointed out that "insulation coördination" is not descriptive of today's approach to the problem of over-voltage protection of stations. Instead, it should be thought of as "coördination of protective devices."

The factors that make up the consideration of a protection problem are: arrester rating, arrester location, and insulation requirements. Armstrong said that the best arrester protection is obtained by the use of the lowest voltage rating possible. This voltage rating must not be less than the highest phase-to-earth power frequency voltage allowed at the arrester location by the system grounding and circuit configuration.

Speaking on shielding practices for medium voltage cables, J. R. Maher of G-E reviewed the latest shielding recommendations from the Insulated Power Cable Engineers Assn, also called attention to the fact that shield losses in single-conductor lead-sheathed cables are often appreciable, and offered suggestions on how to solve the problem.

Feedwater Circuit

Interesting and off-beat was the subject presented by Rex A. Elder of TVA — thermal density currents and their utilization in condensing water design.

Construction of high-head storage reservoirs in the tributaries of the Tennessee River has created conditions which form underflow currents, and TVA now has considerable experience in tapping these cold under-

Continued on page 142

Condensate Flash System Cuts Fuel Bill 25 Per Cent at Delco-Remy

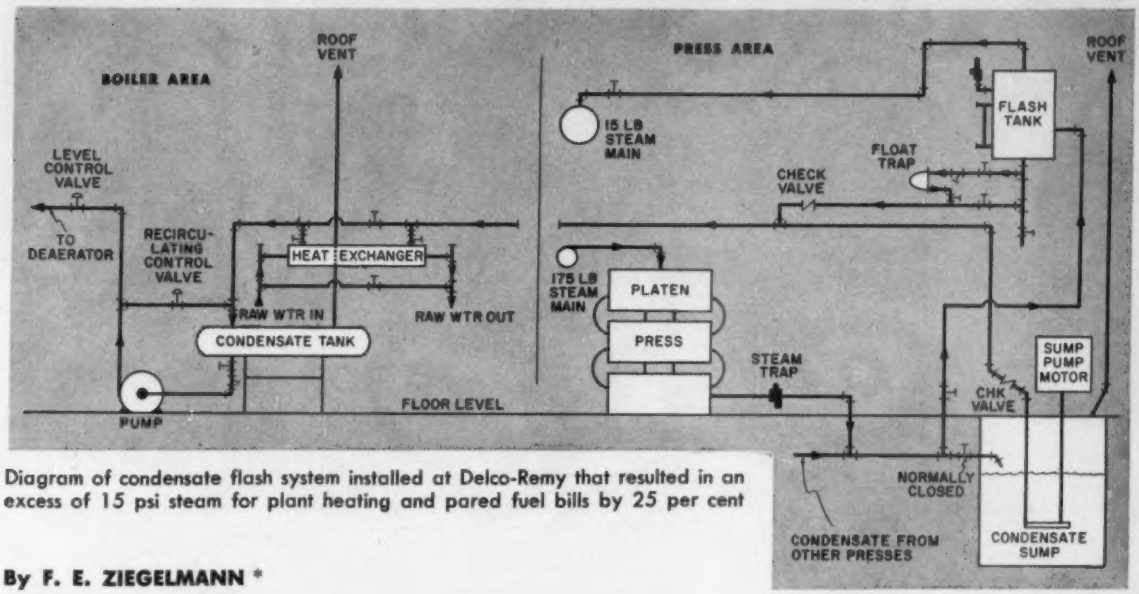


Diagram of condensate flash system installed at Delco-Remy that resulted in an excess of 15 psi steam for plant heating and pared fuel bills by 25 per cent

By F. E. ZIEGELMANN *

OUR PLANT uses process steam at 175 psi in 34 platen presses for manufacture of hard rubber battery cases and covers.

Prior to installation of the condensate flash system described in this article, condensate from these presses drained to a sump vented to the atmosphere. From the sump, it was pumped to the boiler room 300 ft away, to a condensate receiver. This is a system quite common in manufacturing plants; it also is one that results in a great amount of heat loss that can be used to good advantage. We decided to cash in on these losses, and results were far beyond our expectations.

As shown in the diagram, we revamped our condensate system by adding a flash tank at the 15 ft level in the upper bay area above the presses. Condensate drain line to the sump was cut and a tee and valve installed. This point was piped up to the flash tank. Vent from the flash tank was piped to plant low-pressure steam system which operates at 15 psi. A float-trap, strainer, and by-pass were added to the piping system between flash tank and the existing sump pump discharge piping. This pump has a check valve at pump outlet which prevents condensate draining into the sump.

A check valve was also installed in drain line from the flash tank where it enters sump pump discharge line. This prevents condensate backing into the flash tank should need for sump pump operation arise. Sump pump now acts as a stand-by unit.

We use a considerable amount of 15 psi steam for different things such as air conditioning, heating and reheating in process; water heating, manufacturing area space heating, and in a hot lime-zeolite boiler feedwater system which includes a deaerator.

Condensate from the presses now runs to flash tank. Approximately 15 per cent of this flashes into steam at 15 psi. Our main steam load is the platen presses, so it readily can be seen that a considerable saving in steam is effected due to flash tank alone.

Condensate from flash tank is then piped through a heat exchanger, through which hot-lime softener make-up is run. This preheats make-up water somewhat, and further reduces temperature of the condensate below flash point before it is discharged into condensate receiver located in the boiler room. This receiver is vented to the atmosphere. Condensate is then pumped to the deaerator.

System Benefits Boilers Too

Before flash tank was installed, flash steam vented to the atmosphere from the condensate sump amounted to about 18 per cent. This loss had to be made up from raw water at an average temperature of 70 F. Advantage of having condensate return to the boiler room at 210 F instead of using raw make-up water at 70 F is immediately apparent.

Receipt of more condensate in the boiler room also meant that much less make-up. This in turn meant considerably lower solids content in boiler water. Result was a substantial reduction in blow-down to maintain solids at a safe level. Less chemical treatment was required, and control was easier to maintain. Treatment costs therefore were reduced while getting better protection from scale and corrosion.

Since our system for externally treating boiler feedwater consists of a hot lime-zeolite system, boiler water is heated to 245 F from our 15 psi system. Formerly, we obtained this heating steam from 175 psi steam through a reducing valve. Since installation of our flash tank system, however, we recover more 15 psi steam than we need for heating feedwater, and it is obtained after the steam has done its work in producing the product. Product costs are therefore lower.

We also recover all the 15 psi steam necessary for space and hot water heating. Condensate from the presses had been pumped back to the boiler room intermittently. It now flows back as fast as it accumulates, and pumping costs and maintenance are entirely eliminated. This smoother flow also gives better results in the deaerator.

Finally, there is the savings in fuel. During September we used 3128 cu ft of gas to produce 3,198,400 lbs of steam, or 1022 lbs of steam per cu ft of gas. During November we used 3889 cu ft of gas to produce 5,297,600 lbs of steam, or 1360 lbs of steam per cu ft of gas. This adds up to 25 per cent savings in fuel costs. THE END

* Powerhouse Eng'r, Delco-Remy Div of General Motors Corp

Fig. 1. Typical result of corrosion in tubular air preheater. Preventive engineering problems are often extremely complex

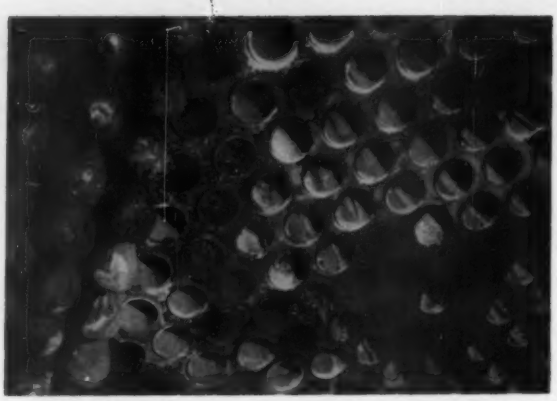


Fig. 2. This heavy deposit is highly acid, causing heavy damage to equipment and frequent expensive outages for lancing

Vanadium Corrosion in Boilers—Cause, Effect and Remedies

By R. S. NORRIS*

VANADIUM IS PRESENT in residual fuel oil, and in crude oil, as a soluble compound, sometimes referred to as a *porphyrin*. During the process of combustion, it is oxidized to one of five oxides: V_2O, V_2O_3, V_2O_3, V_2O_4, or V_2O_5, of which the last is the most important.

This pentoxide, V_2O_5, forms salts, known as *vanadates*. Certain vanadium salts yield an intensely permanent black color, and are applied in the manufacture of inks and dyes. Another of the common uses for vanadium is as a contact catalyst in the manufacture of SO_3, and therefore is important in the commercial production of sulfuric acid. It is also used as a reducing agent, and as a drier for linseed oil paints.

Vanadium has been, and continues to be, obtained commercially from the ash of oil-burning furnaces. It has been a fairly common practice to chip out the slag deposits from furnace floors and boiler uptakes, and to salvage this slag for extraction of the vanadium content. Vanadium is also obtained in association with other ores mined in the United States, Africa, and Peru. It is difficult to refine metallic vanadium in a pure state, but fairly easy to make alloys such as ferrovanadium and nickel-vanadium.

Forms Slag and Deposits

Vanadium pentoxide, V_2O_5, is a reddish-yellow in color. While it is seldom observed in slag formations of boilers to have this appearance, there have been reddish deposits observed on diesel engine piston heads. Upon analysis, this deposit revealed an equivalent to 93 per cent V_2O_5.

Slag formation from oil-fired boilers generally has an appearance in color from gray to black, but with some brownish overtones. Analysis of these deposits frequently indicates the presence of about 60 per cent V_2O_5, although the slag, at the time of removal from a cold boiler, is a complex formation. It contains many of the other ash-forming constituents from the fuel oil, the air, and metals from the boiler surfaces.

Examination of some slag, removed from superheater tubes and hangers, indicates that the entire mass has been in a molten state, having flowed like lava. It is, of course, in the molten state that V_2O_5 causes corrosive attack by fluxing with the protective oxide layer on the steel or alloy, leaving the bare metal exposed to the corrosive oxidation and sulfidation by the sodium, vanadium, and sulfur.

Problems, Hot and Cold

Sulfur corrosion is generally accepted to be caused by the SO_3 present in the products of combustion, and the SO_2 can be practically disregarded. Unfortunately, however, as was mentioned in the opening paragraph, vanadium is a powerful catalyst for the reaction $2SO_2 + O_2 \rightarrow 2SO_3$. SO_3, as a gas, is a severe corrodent in the sulfidation of the superheater accessories, but the problem is further complicated by the fact that the condensation precipitated at the dew point is extremely corrosive to air preheater tubes and other surfaces in the cold zone.

For all practical purposes, one might conclude that the dew point of the gases has been lowered, and it is the sulfuric acid thus formed which is causing frequent replacements of preheater tubes, etc.

To pursue this further, it is interesting to observe that very minute concentrations of SO_3 can cause this severe corrosion in the cold end of boilers. The percentage of SO_2 converted to SO_3 varies with the sulfur (and vanadium) content of the fuel. This per cent converted to SO_3 increases as the content of sulfur in the fuel decreases.

To illustrate this, with a fuel of 4 to 5 per cent sulfur, only 2 to 4 per cent is converted as SO_3, whereas with a 0.1 per cent sulfur fuel, some 30 to 40 per cent is converted to SO_3. A quick calculation will show that sulfur corrosion is not a straight-line function of sulfur content of the fuel, although all will agree that high-sulfur-content fuels are considerably worse.

Effect of Sodium

Figure 3 shows a typical condition of high-temperature corrosion on a superheater hanger which has been wasted away by the sodium and vanadium attack in an oil-fired boiler. This metal wastage does not occur generally to the tubes, since they are kept cooler by the steam passing through them. The metal skin temperature of the fire side of the tubes would not normally be more than 50 F to 75 F higher than that of the steam inside, but the spacers, hangers, and baffles are exposed to the prevailing gas temperature. However, since the tubes are cooler, they serve as a better "collector" on which the vanadates can solidify, and the slag builds up as an insulator.

Thus far we have found vanadium "guilty" as the culprit which corrodes metals in the high-temperature zone of boilers, gas turbines, and diesel engines. If vanadium were the only culprit, this would only occur

*R. S. Norris & Associates

at temperatures above the melting temperature of V_2O_5, which is 1274 F.

However, there are many other elements and compounds present in the oil at the time of combustion, and as pointed out above, since V_2O_5 forms salts known as vanadates, it is unlikely that pure V_2O_5 remains as such in the gas stream for any period of time.

Unless inhibited, there is the possibility that sodium vanadates, which have a melting temperature below 1000 F, may form. For example, a mixture of 75 per cent V_2O_5 with 25 per cent Na_2SO_4 will melt at 950 F, and SO_3 is also released in the reaction.

Possible Remedies

It is possible to reduce the ash content of residual fuel oils by centrifuging, but as was pointed out, vanadium is oil soluble, and the net effect of centrifuging is to concentrate the vanadium in a smaller total ash-forming content.

For example, a fuel, before centrifuging, may contain 0.057 per cent ash of which 8 per cent is V_2O_5. After centrifuging, the ash content is 0.036 per cent, of which 13 per cent is V_2O_5. Obviously this has not lessened the vanadium content of the fuel, but centrifuging does remove some of the sodium from the fuel, since much of the sodium is present from salt-water contamination.

So far, there is no economically feasible process to remove the vanadium and sodium from these fuels at the refinery. Some consideration has been given to the removal of the ash after the oil has been burned, but this involves some form of separator, which undoubtedly involves a loss of heat, and therefore efficiency.

A great deal of research work has been done to develop an alloy metal which is resistant to this attack, but the problem is complicated by the different aspects of the vanadium, sodium, and sulfur. Even if an exotic alloy, or coating, were perfected and economically feasible, there is a further problem of attack on the refractories and brick work in furnaces and boilers.

Aside from these corrosion problems, there is the problem of fouling and loss of heat transfer, and the cost of removal of the deposits formed. Certain trans-Atlantic liners, burning 2500 barrels of fuel oil per round trip, have found it necessary to remove a 10-inch-thick mass of hard, rock-like material from the furnace floors, by chipping hammers, every four trips.

Extreme Toxicity

For the benefit of anyone who is required to clean out or work in boilers, it may be well to mention a safety precaution at this point. The toxicity of vanadates on humans has been recognized for 70 years. The symptoms of vanadium poisoning include a greenish-black discoloration of the tongue and teeth, and a metallic taste in the mouth; irritation of throat and nasal passages with sneezing and an irritating cough; some stomach disturbance, and also a skin irritation where sweating occurs.

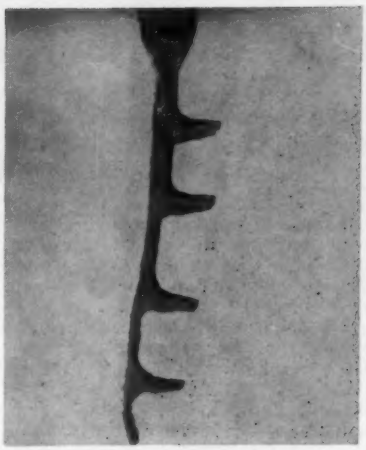


Fig. 3. High-temperature corrosion of superheater hangers means expensive replacements of both hangers and tubes

This poisoning, often referred to as "black tongue," usually clears up within 48 hours after withdrawal from the boiler, except that the discoloration of tongue and teeth may persist for four or five days. The minimum protection for the boiler worker should consist of a coverall secured at wrist and ankle; gloves and boots; and a hood to completely cover the face, provided with an external source of air.

Some Additives Effective

Since removal of the oil-ash corrosives is not practical, it appears that the best approach toward these problems is by means of an additive in the fuel oil. We have mentioned that vanadium pentoxide is formed upon combustion; that V_2O_5 forms vanadates; and, in the presence of sodium, may form vanadates of low-melting point.

Conversely to this phenomenon, many patents have been issued covering the additions to the fuel of such inorganic materials as phosphorus, calcium, zinc, magnesium, barium, aluminum, silicon, strontium, zirconium, and titanium. In practically all cases, it is disclosed that the function of these inorganic compounds is to raise the temperature at which the vanadium complex melts. A great many full-scale attempts have been made to apply such materials as dolomite ($CaCO_3$, $MgCO_3$), magnesite (MgO), Epsom salts ($MgSO_4$), and other similar minerals to the fuel oil.

Test results have been reported with good success in some cases, while others have experienced fouling sufficient to cause early shut-down of the boiler. While these minerals are relatively inexpensive on a price per ton basis, the equipment required for storage, handling, mixing, and injection into the fuel may run into large sums of money.

Only the large central stations of public utilities can justify the capital expenditure and operating expense to apply such minerals in the raw state. What, then, can be done for the thousands of marine and smaller stationary installations confronted with these problems?

There is an additive available, known as Barsad, which is liquid, oil-soluble, and easily applied. This additive contains a high concentration of metallic compounds in a particle size not exceeding 2 microns, which combine upon combustion with the vanadium and sodium to form high-melting-point vanadates.

What It Costs

The question is frequently asked, what does it cost to use a fuel additive, and perhaps even more important, what are the present costs for corrosion and deposits which would justify such an expenditure? Following is a tabulation of these costs as experienced by a typical central station burning some 70,000,000 gallons of high-vanadium-content fuel oil per year:

Problem	Cost per Gal. of Oil Burned, Cents
Boiler fouling and cleaning, including cleanings necessary before repairs can be safely made	0.15
High-temperature corrosion failures of intertube supports, hangers, and beams, making super-heater replacements necessary	0.44
Low-temperature corrosion in economizers or air preheaters	0.20
Total	0.79

Cost to apply this oil-soluble additive in an effective ratio will, of course, vary with the content of the corrosives in the oil. However, when applied at a ratio which added about one and one-third mills ($0.0013) per gallon to the fuel cost, the additive lowers the dew point of the gases through the preheater in such a manner that the extended preheater tube life, alone, justifies the use of the additive.

As mentioned above, the additive had the effect of depressing the dew point of the gases in the cold end of the boiler. In an internal combustion engine, particularly diesels burning heavy fuels, the dew point at the high pressures involved, may be 300 F or higher. It is for this reason that modern diesel cylinder lubricating oils contain additives of high alkalinity to neutralize the sulfuric acids formed.

It is logical, therefore, to assume that an additive in a diesel engine can depress the dew point, minimize the acid formation, and reduce that portion of the cylinder and piston ring wear attributed to an acid-corrosion condition. THE END

Do Power Plants Pollute the Air?

Air pollution remains one of our most serious problems. Electric utilities have done much toward solving it. Here's how they did it

WE CAN ESTIMATE that the total tons of sulfur emitted per day as oxides from electric power plants in the United States varies from about 9500 tons in the summer to 12,000 tons in the winter." So says Arthur A. Orning, Chief of the Combustion Section, U. S. Bureau of Mines.

With more and more of America's population centers discovering a real menace in the problem, air pollution is today coming in for a great deal of attention from all levels of government, as well as from civic groups all over the nation.

Immediate steps to combat this rapidly expanding menace to the national health were recently proposed by the National Air Pollution Conference meeting in Washington, D. C.

A great variety of opinion exists as to where to affix the greatest blame in this situation. Steel mills and chemical plants come in for their share; petroleum refineries are not neglected in assessing responsibility; a loud and vocal group point the accusing finger at electric generating stations. There is a growing feeling that a lion's share of the blame can be laid at the door of the automobile industry for failing to reduce the tons of gas-entrained solids emitted by the nation's autos. That all of these are responsible in varying degree cannot be denied.

Smoke Has Been Conquered

It would appear, however, that in this case the nation's electric utility plants are more sinned against than sinning. No one segment of American industry has done more to eliminate air pollution than have the utilities. Although much still remains to be done, great advances in the technology of smoke abatement and fly-ash entrapment have been made.

Speaking before the National Air Pollution Conference recently, G. V. Williamson of Union Electric Co gave an excellent account of these advances. Said Williamson:

In the burning of fossil fuels under the large steam generating boilers common in the electric utility field, there are still two fields where, by current opinion, much research and development is still needed if such plants are not to contribute to air contamination. On the other hand, three developments have been perfected to the point where, in construction designs of recent years, a high degree of clean-air operation has been achieved. These three developments have been long in coming, have been costly both for their development and now for their adoption, and represent an achievement in accelerated engineering progress typical of the electric industry in the past ten years.

No stack now serving a modern central station boiler shows old-fashioned *smoke* these days, except, possibly, under emergency load conditions, and then for only a few moments. Smoke was, until a generation ago, the sum total of air pollution, and *smoke prevention* is still the descriptive title of many municipal bureaus. By smoke is meant those black, unburned hydrocarbons arising from incomplete combustion, particularly of volatile portions of the fuel. Agglomerations of such black components into fluff-like particles of *soot* are still common from small domestic and commercial heating stoves or furnaces. (*Soot and fly ash*, an expression commonly used by laymen, is a grossly inaccurate one. *Air borne dust and cinders* might be a better one.)

Solution to the problem of black smoke discharge has been achieved by development of fuel-burning equipment and furnaces which lead to complete combustion of oil or coal with adequate air at the right place intimately mixed with the fuel.

Near-elimination of smoke from modern utility plants is not only a notable achievement from the viewpoint of a clear atmosphere; it is of great importance in that current problem of the Compound-X irritant found in Los Angeles. Unburned hydrocarbons are still discharged from many forms of combustion furnaces and engines, and from evaporating sources.

Fly Ash Largely Eliminated

By *fly ash* is meant the cinder discharge associated with both stoker and pulverized forms of coal firing. Central stations have standardized on pulverizing for modern coal firing. They have now attained consistently high efficiency in removal of fly ash from today's chimneys. This has been a long and expensive program. The central station industry has, in some years, utilized 90 per cent of the entire output of dust collector manufacturers.

These collectors are mechanical, electrostatic, or a combination of the two. Efficiencies of over 90 per cent are the rule, and over 95 per cent has been attained in favorable circumstances, such as high resistivity of the coal ash.

Cost of dust collector equipment is great, representing from two to four per cent of the entire cost of the plant. It has been a great mechanical achievement. It has eliminated one source of atmospheric dust as a nuisance to urban life and has required a significant contribution by the American people.

Significant accomplishments have been reached as to stack height in nozzles of optimum plume discharge velocity, and in other essentials of stack design for a maximum performance for the plant area and community.

These developments have been brought on primarily through the use of elaborate wind tunnel studies made at the design stage on models of the plant. Sometimes terrain has entered the studies, as well as stack heights and discharge velocities.

It has happened that the use of high velocity by restrictive nozzles at the stack top have been necessitated by rulings of the Civil Aviation Board calling for low stacks. Where such limitations do not restrict stack height, and where model studies of plant and analysis of terrain show a need, stack heights of up to 750 ft have been designed and built for utility plants. Again, this is an added economic load, but utilities accept it under the philosophy of good neighbor relations.

Problems Currently Under Study

Unsolved, or only partially solved, problems involve the more obscure, less tenable, almost imperceptible elements of stack discharge. These are elements on which there is only the vaguest hint or suspicion of their being objectionable. They are areas where known remedies frequently cause new troubles more severe than the original.

Vast research projects are under way by private industry on means of removing high portions of sulfur from coal. This could be economically significant for metallurgical coals, and for eliminating corrosion of coal burning equipment. Its importance in clean air is only guessed at. Nevertheless, work is under way and more is needed on measurements of sulfur oxides discharged, means for removing sulfur from fuels (coal and oil), and even for reduction of sulfur oxides in flue gas.

There have been recent indications that steam boilers release some objectionable amounts of nitrogen oxides. Work is under way which shows how boiler furnace design can appreciably reduce nitrogen oxide formation. Here again, the quantitative need, as well as the solution, require more measurement and knowledge.

THE END

CONSTRUCTION NEWS

Chula Vista, Calif. — San Diego Gas & Electric Co, 861 Sixth Ave, San Diego, Calif, has work under way on the installation of a new steam-electric generating unit at company's South Bay Power Plant, located here. Installation will have an initial capacity of 135,000 kw and will be equipped with high pressure boilers and auxiliary equipment. South Bay unit will be 25 per cent greater in capacity than any unit now in operation in the company system and when placed in line in 1960, total generating output of entire system will be boosted to more than 807,000 kw. Installation will represent an estimated investment of $25,000,000.

Huntington Beach, Calif. — Southern California Edison Co, 601 W Fifth St, Los Angeles, Calif, has authorized plans for the construction beginning soon of the second steam-electric generating unit at company's Huntington Beach Plant located on U. S. 101, here. Company recently placed in operation a steam-electric generating unit with initial capacity of 220,000 kw on this plant site of 80 acres. A third unit of like capacity is projected for later this year and is scheduled to go on line sometime in 1961 or early 1962. Company has plans to make this power plant the largest in its system. When three units are completed, new plant will represent an investment in excess of $60,000,000.

Sacramento, Calif. — California Department of Water Resources has plans under consideration for the use of steam turbine-powered pumps to help lift 3,500,000 acre-ft of water annually over the Tehachapi Mountains for use in the Southern California area. The plan was revealed in a report covering aqueduct routes down the San Joaquin Valley and into Southern California. Also outlined is a 5,500,000 acre-ft San Joaquin Valley-Southern California aqueduct system with a total length of 638 miles including all its branches. The steam turbine-powered pumps would be involved in a single lift of 2165 ft. The spectacular operation would be in three stages, the first two powered by synchronous motors; and the third driven by direct drive steam turbines.

Hartford, Conn. — Connecticut Light & Power Co, 266 Pearl St, has authorized a construction budget approximating $3,300,000 for the building, rebuilding, and converting of company's transmission and distribution lines in its service areas. Work will include new transmission line from Derby Tap to Beacon Falls at a cost of $350,000; transmission line from Glenbrook to Norwalk at a cost of $280,000; the rebuilding and converting of a 69-KV transmission line from Montville to Willimantic to 115-KV capacity approximating the expenditure of another $2,450,000; and the construction of a transmission line from Frost Bridge substation to Southington at an estimated $220,000.

Atlanta, Ga. — Georgia Power Co, 52 Fairlee St, NW, this city, has announced plans for major expansion and improvement in utilities' transmission and distribution facilities involving a total $4,500,000 for the work to be done on day labor basis. Plans call for the construction of a 230,000-v electric transmission line from Columbus to Tifton, Ga., and a 230,000-v substation at Tifton, Ga., to serve Muscogee, Chattahoochee, Webster, Lee, Woth and Tift counties. Work will get under way at once for completion in the spring of 1961.

Estherville, Iowa — City Department of Light & Power, City Hall, here, has plans in progress for expansion and improvements in municipal power plant, with installation of 3,000–3,500-kw diesel electric generating unit, along with auxiliary equipment. Cooper-Bessemer Corp, Mt. Vernon, O., has been awarded the $763,260 construction contract. Work will get under way at once for completion by the summer of 1960.

Somerset, Mass. — Stone & Webster Engineering Corp has been awarded a contract to participate in the design and to supervise construction of a new 225,000-kw power station in Somerset, near Fall River, Mass., for the New England Electric System.

Engineering work on Unit No. 1 of the new steam power station, to be located at Brayton Point on Lee River, is already under way.

Stone & Webster recently completed work on a new 150,000-kw generating unit at the Salem Harbor Station of New England Electric.

Coldwater, Mich. — City Light & Power Dept, City Hall, has plans under consideration for the construction of new power plant with installation of new turbine generator unit, estimated to cost about $7,000,000. Proposed installation will get under way as soon as bond issue for the work is voted on and approved.

Springfield, Mo. — City Utilities of Springfield, 301 E. Central St, has announced contract award to the Midwest Piping Co, Box 433, St. Louis, Mo, in the amount of $632,950 for construction of power piping in connection with installation of new 44,000-kw steam-turbine generating unit at municipal James River Power Station located here. Work will get under way at once for completion scheduled for spring of 1960. Burns & McDonnell Engineering Co, Kansas City, Mo, is consulting engineer of the installation.

Akron, O. — Ohio Edison Co, 47 N. Main St, has authorized plans for the expenditure of about $60,000,000 on new construction during 1959. Major items in the construction program are $25,285,000 for steam production facilities, $16,500,000 for transmission lines and substations, and $14,895,000 for distribution lines. Over the next four years company plans to install 680,000 kw of new generating capacity at its new plant at Stratton, O. First unit with initial capacity of 170,000 kw is expected to go into service in the summer of this year. Units two, three and four of like capacity are slated to go into service in the summers of 1960, 1961 and 1962, respectively.

Saxton, Pa. — Westinghouse Electric Corp, Atomic Power Div, Box 1468, Pittsburgh, Pa., has announced plans for the construction of a 5,000-kw atomic power plant for General Public Utilities Corp's Pennsylvania Power Co subsidiary here. The reactor will be of the pressurized water type, pioneered in the Navy submarine project, and will be hooked on to an existing turbine generator unit of the Pennsylvania Power Co station here. The reactor is scheduled for operation by the summer of 1961 and is estimated to cost about $10,000,000. Plant will be a joint undertaking of Westinghouse, General Public Utilities and Gilbert Associates, Inc, of Reading, Pa., an architect-engineering concern.

Columbia, S. C. — The Atomic Energy Commission and the Carolinas Virginia Nuclear Power Associates have announced that final agreement on Federal aid for a proposed atomic power plant to be constructed 25-miles northwest of here has been reached. Plant will be powered by a pressurized water reactor, fueled with enriched uranium. Heavy water will be used to make the atomic chain reaction more efficient. Plant when completed in mid-1962 will generate 17,000 kw of electricity and will cost approximately $22,000,000 to be paid by the CVNPA group formed expressly for the purpose of constructing the power plant. AEC has agreed to pay all research costs and to provide atomic fuel and heavy water for five years.

Pearsall, Texas — Medina Electric Co-operative, Hondo, Texas, has plans under consideration for the construction of a new steam-electric generating plant, two miles northeast of this town. Work will include installation of a steam-electric generating unit with an initial capacity of 66,000 kw, high-pressure boilers, and auxiliary equipment. Cost of the new power plant is estimated to be about $12,000,000. Larimore, Douglass, & Popham, Chicago, Ill., is consulting engineer of the project.

Appleton, Wisconsin — The Appleton mill of Consolidated Water Power & Paper Co will step up by 47 per cent its capacity for burning spent sulphite liquor which previously was discarded into the Fox River with construction of a new boilerhouse early this spring.

Construction schedules call for completing the installation in time for full-scale operation of the new plant by next winter.

A new steel and metal building will be erected to house two new boilers that will replace six smaller capacity units. One new boiler is designed to burn oil and 20,000 lbs of 55 per cent concentrated spent sulphite liquor per hour while the other will burn oil and bark. Capacity of the present plant is 13,600 lbs per hr. Oil selected as a basic fuel for the new boilers because of greater ease in controlling the mixed firing of oil and concentrated liquor and because of lower operating cost.

Glenrock, Wyo. — Pacific Power & Light Co, Public Service Bldg, Portland, Ore., has authorized plans for major addition to company's Dave Johnston steam power plant, located this city. Installation will include a 100,000-kw turbine generator unit, high pressure boilers, and auxiliary equipment. Work will get under way at once for scheduled completion by late 1960. Cost of plant installation including transmission lines reported to be about $18,000,000.

Power Engineering handbook

Testing and Repair for Insulation Resistance

By KENNETH G. ELLISON*

OVER THE YEARS, periodic checks have been made on the insulation resistance of electrical apparatus such as motors, generators, transformers, cable and control wiring. This has been done in order to detect faults before they become serious and through minor repairs, corrections can be made.

Otherwise, vital equipment might fail without warning, resulting in equipment being forced out of service for costly and time-consuming repairs and perhaps necessitating purchase of power.

Insulation resistance is resistance to the flow of direct current through or over the surface of insulation in electrical equipment. The insulation test is non-destructive.

The test instrument is called a megger. Most meggers used in the plants develop a 500-v direct current when the instrument is cranked by hand. Using suitable leads, the voltage is applied to a bare terminal of the apparatus and the frame, or "ground." When the instrument is cranked, the insulation resistance in megohms (megohm equals 1,000,000 ohms) is read from the scale.

An often used value for satisfactory insulation resistance is 1 megohm for each 1000 volts of the apparatus rating with a minimum of 1 megohm.

Recent routine megger tests, conducted two days apart, indicated very low insulation resistance on the rotating field winding of both No. 13 and No. 14 generators at Conners Creek station.

* Electrical Engineer, Detroit Edison Co. This article appeared originally in Coal to Kilowatts

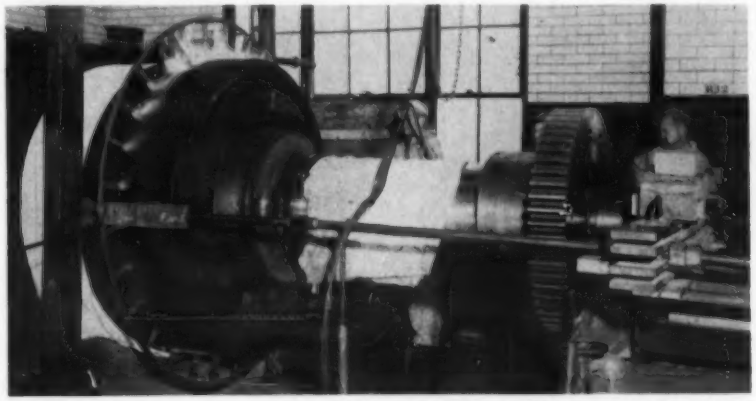


Fig. 1. Rotor was removed from generator, and then retaining rings, so as to expose coils beyond slots

fold along this line—outside edges toward you

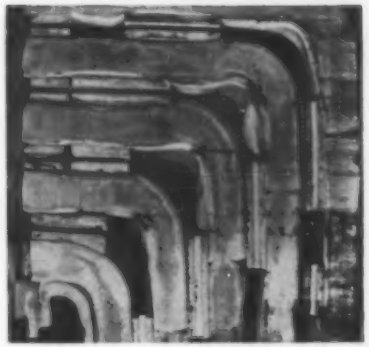


Fig. 2. After 21 years of rotation at 1800 rpm, coils had understandably lost some of their shape

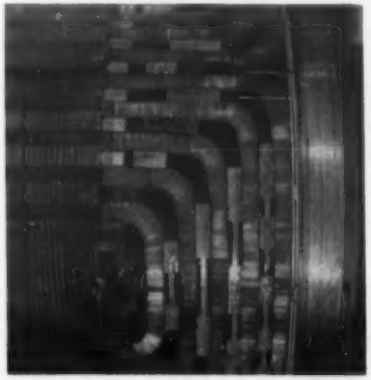


Fig. 3. Textolite, an asbestos-base material, was used instead of replacing the aluminum blocking

The rotor from No. 13 generator was removed and then the retaining rings (Fig. 1), to expose the coils beyond the slot portion. Figure 2 shows that the coils had lost some of their shape after approximately 21 years of rotation at 1800 rpm. The centrifugal forces combined with alternate expansion and contraction of the copper finally resulted in a weakening of the insulation.

When these generators were originally manufactured, and for several years after, the practice was to shape sheets of aluminum, called saddles, over the insulated coil and turns. To hold the saddles in place, aluminum wedges were driven between the coils to secure them against movement; then a retaining ring was placed over the assembly.

Now, after this long period of operation, these adverse forces finally caused the coils to distort and buckle the saddles. In some areas the insulation had cracked permitting the copper to come into contact with the aluminum as the rotor revolved.

The manufacturer made repairs by removing the aluminum saddles and wedges and then applying additional tape over the end turn insulation. No attempt was made to reshape the deformed coils as more harm could result in movement of the dried-out insulation during this period of operation.

Instead of replacing the aluminum blocking, Textolite, an asbestos-base material was used. Individual pieces were shaped to fit between the coils and slots cut in the material, permitting a piece to be fitted around the circumference to act as a key (Fig. 3). Insulation was added on top of the coils and the retaining rings were then replaced.

The same type of repair has proved to be satisfactory on turbine generators Nos. 11–13–14 and 15 at Delray, Nos. 2–3 and 5 at Trenton Channel.

Case of the Wandering Decimal Point

. . . In the Handbook for February, page 100, C. M. Gillespie presented four examples in explaining how to square root to four-digit accuracy. Example No. 4, as printed, was to find the square root of .8764; but as any reader who followed through the calculations would have seen at once, the subject should have been 8.764. Sorry for the confusion.

cut along this line

Progress in water conditioning . . .

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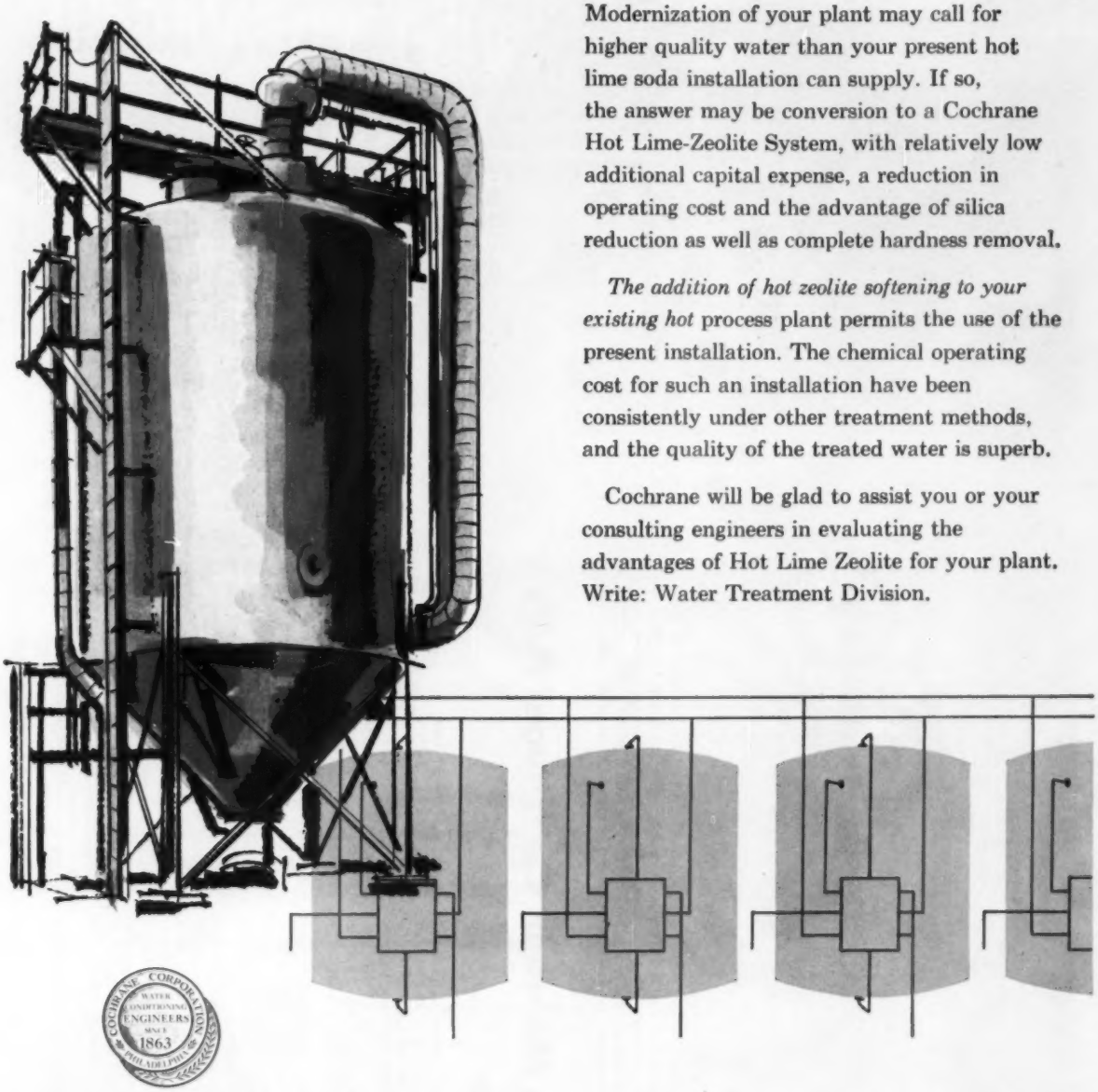

Modernization of your plant may call for higher quality water than your present hot lime soda installation can supply. If so, the answer may be conversion to a Cochrane Hot Lime-Zeolite System, with relatively low additional capital expense, a reduction in operating cost and the advantage of silica reduction as well as complete hardness removal.

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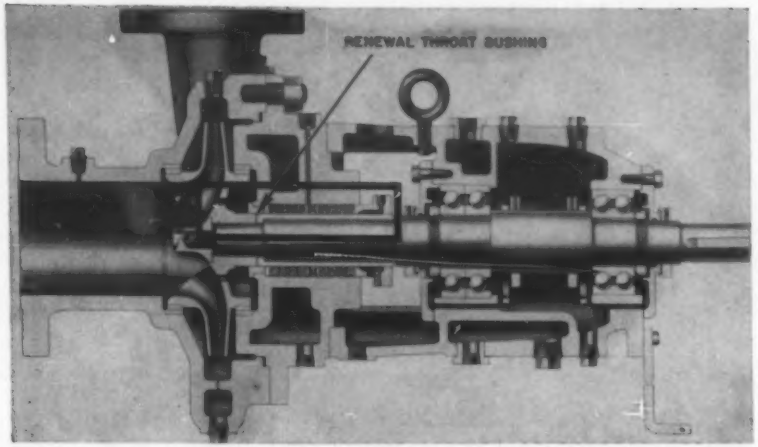

Fig. 1. Stuffing box provided with a renewable throat bushing which is installed from the impeller side of the stuffing box and tack-welded into position. Close clearance between bushing and shaft sleeve cuts infiltration into stuffing box to a minimum. In case of seal or packing failure, bushing remains in position and will not blow out. Leakage is held to a minimum and danger of accidents reduced

How to Maintain Centrifugal Pumps

7 — Casings

By J. A. CABLE * and O. M. KRISTY, Jr.*

THE CASING of a centrifugal pump contains and gives direction to the flow from the impeller. At the same time its volute passage endeavors to convert the velocity energy coming off the impeller into pressure energy by the time the liquid leaves the casing discharge outlet connection.

For the most part, casings fall into two classes—single suction vertical split and double suction horizontal split. Let's first discuss their common factors and then where they differ.

Any casing is good for the normal pressures that a pump may develop. However, the outlet pressure is the sum of inlet plus developed pressure. Therefore, be sure to tell your pump supplier of any unusually high positive suction pressures, so that casing materials and bolts holding the halves together can be amply designed.

Cast iron is the common material for casings. Most pump manufacturers try not to test the casing beyond 2500 psi for Class 25 cast iron, thus using a 10X safety factor. The joint-holding bolts are usually steel of about 75,000 tensile strength, with the test limit not stressing the bolts over 15,000 giving a 5X safety factor. On this basis the pump manufacturer establishes a maximum working pressure usually based on a hydrostatic test that is 150 per cent of maximum working pressure. This results in a 50 per cent increase in the safety factors if you abide by these maximum working pressures. Here, then, is a way to figure a safe retiring

* Application Engineer and Supervisory Engineer, respectively, Centrifugal Pump Dept, Allis-Chalmers Mfg Co

fold along this line—outside edges toward you

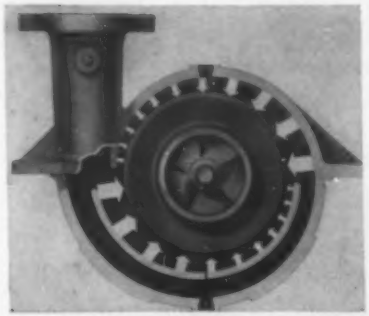

Fig. 2. When pump operates at other than its point of best efficiency, unequal radial forces are set up. In single volute casings, these forces may deflect the shaft and cause excessive wear on packing and wearing rings. A double volute casing will greatly reduce the deflection forces

thickness for cast iron pump casings:

$$\frac{\text{Original Thickness}}{\text{Safe Minimum Thickness}} = \frac{\text{Recommended Maximum Working Pressure}}{\text{Your Maximum Pressure}}$$

For example, a casing ½-in. thick is recommended for pressures to 200 lb. If you use it at only 100 lb, a reduction to ¼-in. thick would not be dangerous. Exception: Don't let any casing get below ¼-in. thick. Casting irregularities could make it unsafe despite any formula solution. Any change in materials would, of course, alter the recommended limits. (Note: the casing material only would be affected by wear; the bolt stress is not affected.)

In the past, a switch to cast carbon steel has doubled casing casting strengths. Today, nodular iron or ductile iron will accomplish the same thing less expensively. This material is also as good as steel in being non-fragmentary. This permits its use in oil refineries and similar areas on an equal basis with steel.

Although these materials double the casting strength, attention must also be given to the bolting, since the two limits go hand in hand. The use of SAE 4140 bolts instead of carbon steel can help increase bolting working pressure limits from 15,000 to 20,000 psi. If additional strength is needed, the number of size of the bolts should be increased. With single suction pumps and their round joint, it is often quite easy to add bolts between the original ones, thus doubling the bolting. Special bolting for double suction pumps is quite expensive due to their irregular location.

On the other hand, if you want to reapply an existing pump to a higher pressure service, you can often get more pressure strength by buying a replacement casing of a better material. When this is contemplated, you should first check with the pump supplier so that he can investigate bolting and casing material strengths as related to your proposed application.

In either single or double suction pumps there are a few points where casing wear can concentrate. Good buying habits can make this wear less troublesome. The impeller runs in close proximity to the casing in the area where the suction passage adjoins the discharge volute. There the casing should be protected with a replaceable wearing ring, tightly fitted into the casing so that liquid cannot get under it.

Particularly in double suction pumps is it important for the joint gasket to be replaced with a new one of the proper thickness. A gasket that is too thick can let water get between the casing ring and the casing. On the other hand, a too thick gasket will result in distorting the rings to the point where they may rub on the impeller or its rings.

Another possible point is the stuffing box inner end, often called the throat. Double suction pumps are often equipped with throat bushings (also called casing or stuffing box bushings) to guard against casing wear at this critical point. In single suction pumps, many manufacturers provide throat bushings as a nominally priced modification.

Proper pump design in single suction pumps must take into consideration both the casing and impeller. If an open impeller is required, be sure to get a casing that provides a means of supplying a replaceable side plate so that the plate rather than the casing takes the brunt of the wear. With small (up to 8- or 10-in.) pumps, this means getting a unit with the casing split ahead of the impeller. With larger solids-handling pumps, it is usually possible to get replaceable wear plates. A quality pump of

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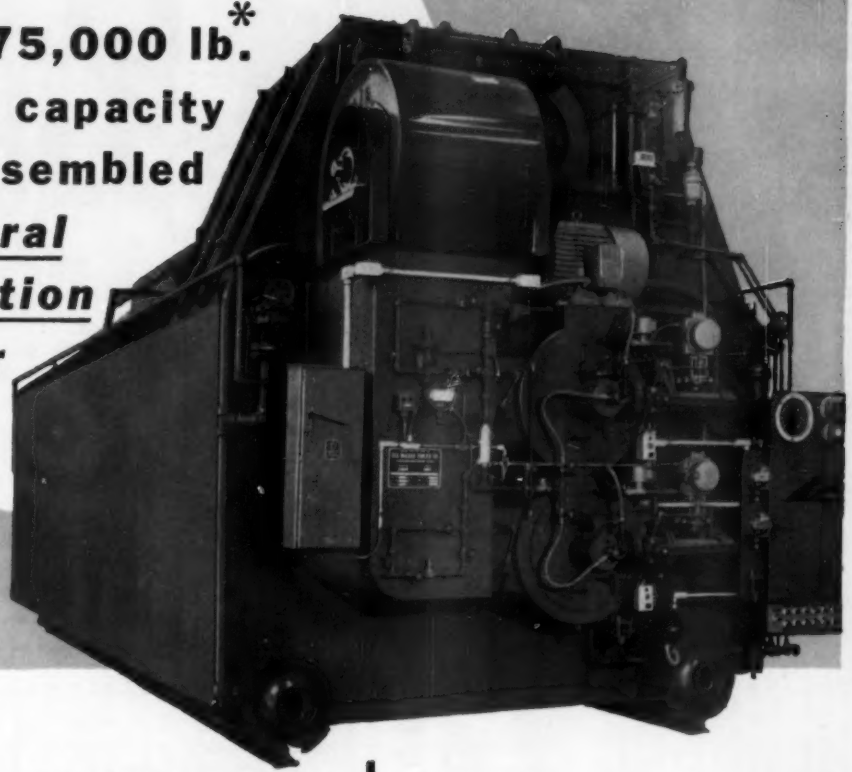

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this type has such a plate even with enclosed-type impellers.

With any pump, *don't* pipe up to the casing so as to have to force the connections to the suction, or discharge casing flanges. It isn't fair to the casing or any of the close running clearances inside the pump to invite possible distortion due to improper piping.

Casings ordinarily require little maintenance, but when the pump is down for other internal inspections or parts replacement, it is well to inspect the water passages thoroughly. The ring fits should also be checked at that time to be sure that water has not cut through behind them. Brushing loose scale and deposits out of the water passages can improve efficiencies several points, so it is wise to clean up those areas when pumps are taken apart.

One of the early signs of poor suction conditions can show up in pitting of the baffles in the top of each suction passage. These baffles are intended to reduce prewhirl at the point where water enters the impeller. If the side of the baffle nearest the impeller is getting pitted, it would be well to check suctions conditions for possible plugging of lines, malfunction of float controls, or poor inlets into suction line.

Next chapter will discuss baseplate and couplings

Improving a Simple Device for Beveling, Concaving Brushes

ON HANDBOOK pages 101 and 102 of the December, 1958 issue of POWER ENGINEERING there appeared an article titled, A Simple Device for Beveling, Concaving Brushes. This article was adapted from the *Bureau of Ships Journal*. The originator and designer of the device described, V. E. Gardner of Arlington, Va., reports that the article can now be supplemented by a few improvements, which are described below.

A section of 60 grit silicon carbide (carborundum) belt, it has been found, makes a better and a more durable abrasive than the flint abrasive (sand) paper described in the article. Care must be taken, however, to remove all particles of the abrasive from the brush face before installing the brush in the motor or generator, for this abrasive will damage the commutator or collector ring.

Because of the sizes of the pages of the Handbook it was necessary to reproduce Fig. 3, which was the plan view of the elliptically-curved part, to less than half scale. If trouble has been encountered in reproducing this figure to full scale, the following procedure is suggested:

Fold an ordinary sheet of writing paper twice to form a 22½-deg angle, as shown here. Determine the point A at which the distance AB is equal to a certain dimension on Fig. 3. The length AC will then be equal to the desired full-scale dimension. (The sine of 22½ deg is 0.38268, which is approximately equal to the ratio of a dimension on Fig. 3 to the corresponding dimension of the full-scale figure.)

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Guide to Requirements For Compressed Air

By JOHN D. CONSTANCE, P.E.

IN SIZING compressed air systems, the engineer must have some idea of the free-air requirements for his tools and appliances. In most plants the general air supply is maintained at 100 psi, and allowing for pressure drop in the distribution system, the 90-psi pressure indicated in the table is a practical one.

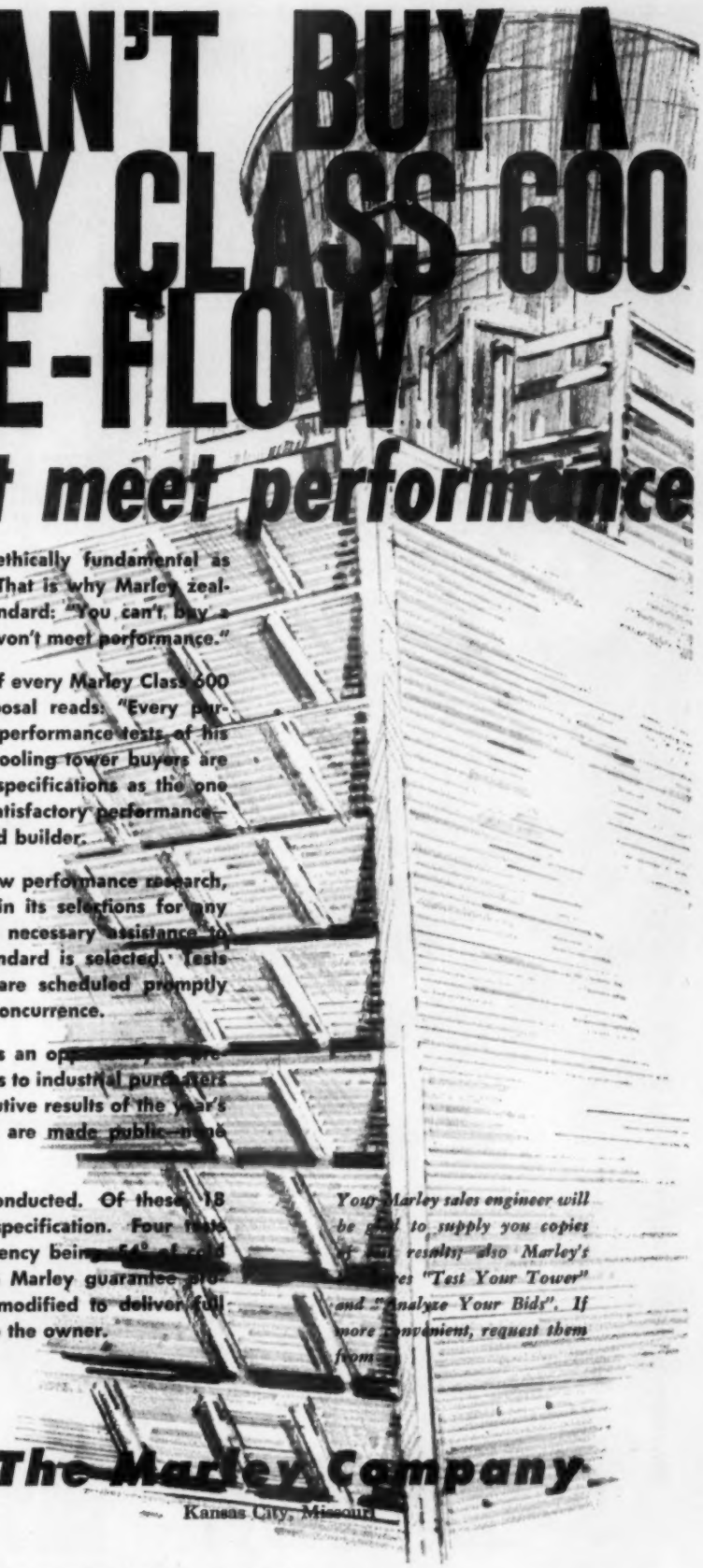
When making his final selection, the engineer should obtain guaranteed flows from reliable manufacturers who may ultimately furnish the tools or equipment, since the table gives good estimating flows. A safety factor should be considered for use with units that undergo wear and abrasion during normal use, i.e., sand blast, providing for greater initial capacity to size up the air compressor.

This table shows average cfm free air consumption for pneumatic tools with air supplied at 90 psig

DESCRIPTION OF TOOL	CFM	DESCRIPTION OF TOOL		CFM
HAND GRINDER				
1½" wheel	12	1¼"		38
2" "	16	1¾"		50
4" "	28–35	JACKS		
6" "	40–45	Cylinder diam in.		
8" "	50–60	8		1.8
HAND RIVETERS		10		2.8
4" stroke	32	12		4.0
5" "	34	14		5.0
6" "	37	16		6.9
8" "	38	20		11.1
10" "	40	24		16
RIVETING MACHINES	50	AIR MOTORS		
RIVET BUSTERS	55–60	2 hp		40–50
HAND SANDERS		4		60–70
7"	35	5		90–100
9"	45	8		140
CHIPPING HAMMERS		15		240
1½" to 4"	20–25	ROTARY STEEL DRILLS		
SCALING HAMMERS	15	¼" Drill size		20
AIR HOISTS		½"		28–32
500–1000 lb	0.5	⅝"		36–42
2000 lb	2	⅞"		55
3000 lb	3.2	1"		65
4000 lb	6.3	1¼"		85
6000 lb	8.4	2"		90
GEARED HOISTS	per ft lift	SCREW DRIVERS		12–20
1 ton	3	NUT RUNNERS		
1½	5	¼" Bolt size		12
2	6	⅜"		22
3	8	½"		38
4	10	¾"		42
5	15	1"		46
6	20	SAND BLAST		
8	25	Nozz. Size	Lb sand/hr	
10	30	⅜"	500	50
IMPACT WRENCHES		¼"	900	95
¼" Size	8–9	⅜"	1700	210
⅜"	12	½"	3000	375
½"	22	TUBE CLEANERS		200
¾"	28			

cut along this line

YOU CAN'T BUY A MARLEY CLASS 600 DOUBLE-FLOW *that won't meet performance*



Full-performance towers are as ethically fundamental as "twelve bananas to the dozen." That is why Marley zealously conforms to this single standard: "You can't buy a Marley Class 600 Cross-Flow that won't meet performance."

That is why an important part of every Marley Class 600 Double-Flow or Single-Flow proposal reads: "Every purchaser is urged to make thermal performance tests of his Marley tower." Each year more cooling tower buyers are including test provisions in their specifications as the one possible method of determining satisfactory performance—of mutual importance to buyer and builder.

Backed by 20 years of Cross-Flow performance research, Marley has complete confidence in its selections for any duty, so customers are given all necessary assistance to facilitate testing by whatever standard is selected. Tests conducted by Marley engineers are scheduled promptly and must receive customer's full concurrence.

Marley welcomes tower tests as an opportunity to present the quality of Class 600 towers to industrial purchasers by publishing annually the consecutive results of the year's testing program. ALL test results are made public—none are deleted.

During 1958, 22 tests were conducted. Of these, 18 indicated capacity in excess of specification. Four tests were deficient, the greatest deficiency being 5½° of cold water temperature specified. The Marley guarantee provides that these four towers be modified to deliver full performance without added cost to the owner.

Your Marley sales engineer will be glad to supply you copies of test results, also Marley's procedures "Test Your Tower" and "Analyze Your Bids". If more convenient, request them from—

MARLEY

The Marley Company

Kansas City, Missouri

For more data circle 545 on Post Card

Nomogram for Determining Draft Differential

By NICHOLAS S. HODSKA*

IN AUTOMATIC combustion control, to calibrate correctly the air-flow controller to the boiler, draft differential data is obtained by test. Calibration data must be obtained while operating with the highest practical combustion efficiency. Draft differential through a boiler, preheater, or orifice varies as the square of the amount of gas flowing through it, and since the steam flow from the boiler is proportional to the gas flow through the boiler for a given combustion efficiency, which can be expressed simply by

$$\left(\frac{W_1}{W_2}\right)^2 = \frac{D_1}{D_2} \quad (1)$$

and $$D_1 = \left(\frac{W_1}{W_2}\right)^2 \times D_2 \quad (2)$$

where W_1 = steam flow at one load,
W_2 = steam flow at another load,
D_1 = furnace draft differential at load W_1,
D_2 = furnace draft differential at load W_2.

It is also necessary to obtain tachometer suction data by test in order to calibrate correctly the fuel-feed controller to the boiler and to the fuel-burning equipment with which it is used. Suction of the tachometer blower is proportional to the square of the speed of rotation of its impeller. Rate of fuel feed is directly proportional to the speed of the stoker. Suction of the tachometer blower is expressed in terms of the steam load as

$$\left(\frac{W_1}{W_2}\right)^2 = \frac{S_1}{S_2} \quad (3)$$

and $$S_1 = \left(\frac{W_1}{W_2}\right)^2 \times S_2 \quad (4)$$

where W_1 = steam flow at one load,
W_2 = steam flow at another load,
S_1 = tachometer blower suction at load W_1,
S_2 = tachometer blower suction at load W_2.

The entire automatic control range is represented on the scale of the controller. Draft differential and suctions for the corresponding loads and positions on the scale are as follows:

Scale Position	Load (Lb of steam per hour)	Differential (In. of water)	Suction (In. of water)
Minimum	10,000	.02	.05
2	20,000	.09	.21
4	30,000	.20	.48
6	40,000	.36	.84
8	50,000	.56	1.32
Maximum	60,000	.81	1.90

Example

At a test load of 30,000 lb of steam per hour, the draft differential is given as 0.20 in. of water and the tachometer blower suction is given as 0.48. Using these data, assume a load of 20,000 lb of steam per hour and determine the other draft differential and the other tachometer blower suction, S_1.

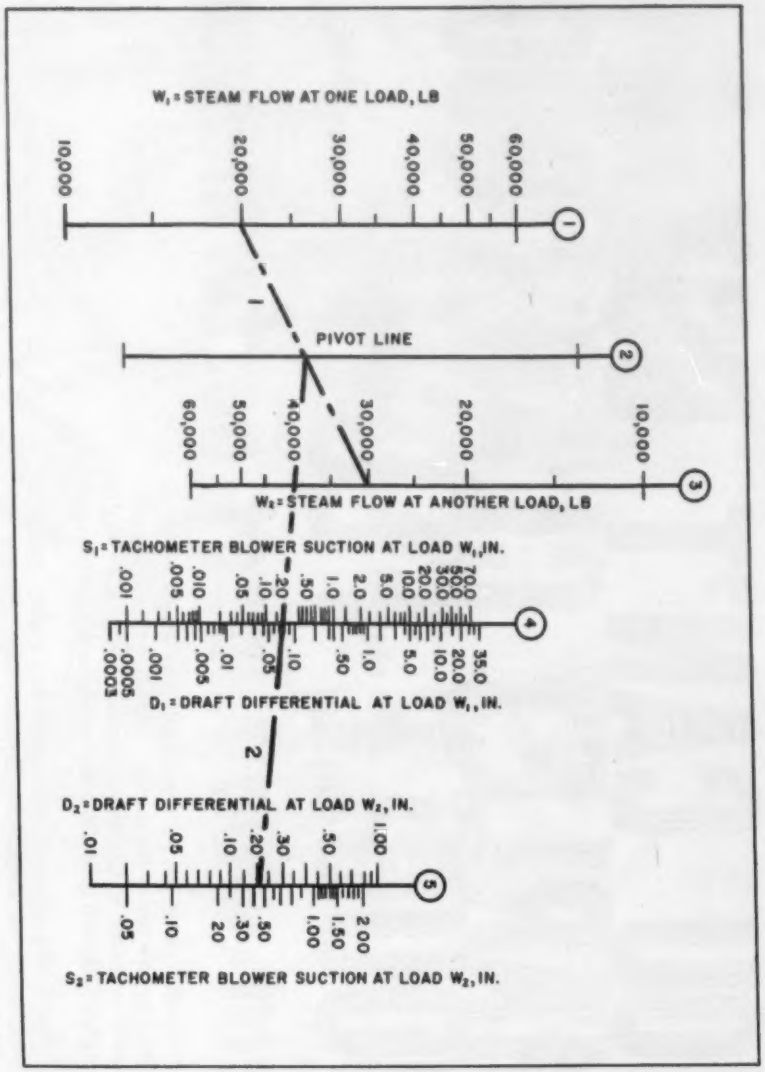
Solution: using the nomogram, draw a straight line connecting $W_2 = 30{,}000$ value on scale 3, to $W_1 = 20{,}000$ value on scale 1. Using point just found on the pivot line, on scale 2, and connecting the $D_2 = 0.20$ value and the $S_2 = 0.48$ value on scale 5, read the draft differential value $D_1 = 0.09$ in. and the tachometer blower suction value $S_1 = 0.21$ in., respectively, on scale 4.

The above two test readings may be checked against one other by means of the scale shown in the table, to determine how accurately the readings were taken. The nomogram gives D_1, S_1, and D_2, S_2 simultaneously and covers the entire range from 10,000 lb to 60,000.

Data is by courtesy of The Hays Corporation of Michigan City, Ind.

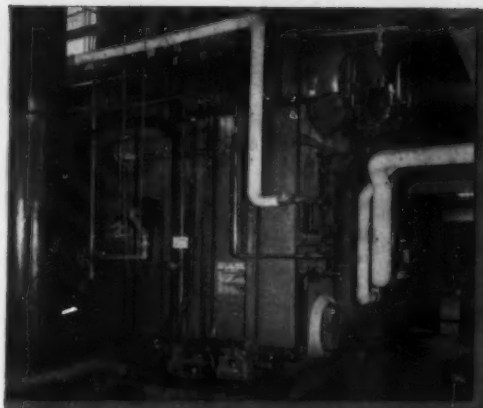
*Sikorsky Aircraft Corp, Stratford, Conn.

fold along this line—outside edges toward you


W₁ = STEAM FLOW AT ONE LOAD, LB
10,000
20,000
30,000
40,000
50,000
60,000
PIVOT LINE
W₂ = STEAM FLOW AT ANOTHER LOAD, LB
S₁ = TACHOMETER BLOWER SUCTION AT LOAD W₁, IN.
D₁ = DRAFT DIFFERENTIAL AT LOAD W₁, IN.
D₂ = DRAFT DIFFERENTIAL AT LOAD W₂, IN.
S₂ = TACHOMETER BLOWER SUCTION AT LOAD W₂, IN.

This nomogram for determining draft differential gives D_1, S_1, and D_2, S_2 simultaneously and covers the entire range from 10,000 lb to 60,000 lb. The broken lines apply to the example given in the text

cut along this line



A 15,000 lbs/hr unit in a hardboard plant

Boilers in various stages of completion in our shop

More Steam per dollar of investment with Vogt

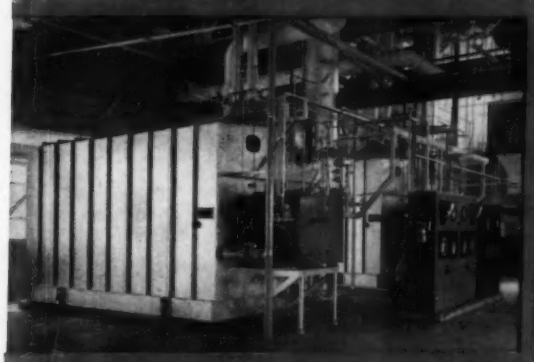
PACKAGE WATER TUBE BOILERS

Completely shop fabricated, with burners, controls and accessories installed before shipment.

Placed on a suitable foundation, only fuel, water, breeching and steam connections need to be made to place unit in operation. Vogt Package boilers are available in oil and/or gas fired types in standard pressures of 175, 250 and 375 pounds per square inch gage.

One of two 30,000 lbs/hr units for a hospital

This 18,000 lbs/hr unit is one of two for an office building



Two 25,000 lbs/hr units installed in a manufacturing plant

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LOUISVILLE, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati

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EQUIPMENT NEWS

Reader Service Cards on pages 129–130 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—PIPELINE STRAINERS made entirely of plastic

Housing, strainer and gasket of these units are constructed of polyvinyl chloride. The plastic strainers are designed to trap particles that would be hazardous to the internal moving parts of process equipment, and their light weight permits installation directly upon delicate equipment. Sizes range from ½ through 2 in., with socket weld ends for solvent weld connections or molded thread ends. Strainer element is accessible for cleaning or replacement. Vanton Pump & Equipment Corp.

2—CLEAR COATING for long term protection of aluminum

Plas-Chem 1200 Clear is said to possess a unique combination of properties whereby it dries quickly to form a tough, glossy film which will not discolor when exposed to ultraviolet, radiation, and exhibits outstanding salt spray and chemical resistance. Excellent adhesion to aluminum is claimed. Coating may be applied by roller, brush, spray or dip. Plas-Chem Corp.

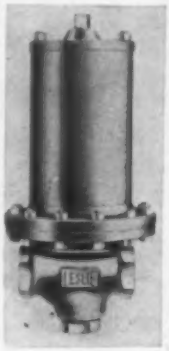
3—POWER PACK combines both silicon charger and battery

Peak d-c power for tripping circuit breakers is reportedly assured by the Auto-Cal Unitized Power-Pack which combines high capacity lead-calcium grid control batteries and a compact silicon charger. The latter (manufacturer's AutoReg) serves to keep the battery (PlastiCal) fully charged automatically, so that a sudden demand for tripping power merely discharges the battery over a short period of time. During the time the breaker is tripped, the battery can also supply necessary constant load current that might be required for pilot lights, holding coils etc. Once the circuit is closed for normal operation, the charger goes to work putting energy back into the battery.

Mounting versatility is a feature. The charger may be mounted on the door of the individual circuit breaker cubicle; wall mounted near a bank of indoor switchgear or above existing battery racks; or relay rack mounted — or the unitized cabinet of charger and battery may be mounted adjoining outdoor switchgear. The AutoReg Charger is described as a maintenance free, voltage regulated, current limiting charging unit operating from a 115-v, 60-cycle single-phase source. It is noted that the lead calcium grid batteries require very much less current than conventional stationary batteries to maintain fully charged condition. Therefore the PlastiCal Batteries are maintained by the charger at slightly higher float voltage values, eliminating equalizing charges. C & D Batteries, Inc.

4—PRESSURE REDUCING VALVE utilizes mechanical pilot

The Leslie-Topper Pressure Reducing Valve employs a mechanical pilot device which is out of the path of steam and therefore eliminates close fitting parts, company announces. Performance tests of this valve, as compared with other types of steam pressure reducing valves, are reported to show a flat capacity-regulation characteristic indicating close control throughout the operating ranges. Data in Bulletin 582. Leslie Co.



5—LIQUID LEVEL CONTROL is probe type unit

This liquid level controller is made with single or dual fittings and with extensions of 1, 3 or 5 ft. The probes provide a complete liquid level control when used in conjunction with electronic or transistor relays. Since these probes have no moving parts they will not fail to operate due to sticky floats, manufacturer states, and they are unaffected by normal changes in temperature and pressure and by the consistency of the liquid. Other features include stainless metal parts, Neoprene rubber splash hoods. Cutler-Hammer Inc.

6—EVAPORATIVE CONDENSERS sized in standard units

Components, condensing coils, casing sections and spray equipment of these evaporative condensers are organized and sized as a line of standard units that can be assembled as machines to fit close to actual capacity needs of an existing refrigeration plant, or make provision for expansion according to load requirements. Condensers are available in sizes from 10 to 190 tons refrigeration capacity in increments of 10 tons in each of the intermediate sizes, and in increments of 25 tons in sizes from 200 to 350 tons. Standard units are designed for field assembly and, all components being detachable, feature simplified maintenance. Niagara Blower Co.

7—NUCLEAR CONTROL MODULES group into "customized" systems

These compact, nuclear "building block" control modules offer flexibility in meeting individual requirements of virtually any type of reactor or operating need, it is stated. They are reported to simplify calibration, operation and maintenance to let the operator check his control system and its components while the reactor is in operation. They come in four basic control channels: pulse channels, to measure rise of neutron flux from source levels to intermediate power range; log N or intermediate channels, to monitor and control rate of change of flux levels to full power; linear-servo channels, to change power levels smoothly; safety channels, with load-sharing features to eliminate problems of false scrams but still provide protection. Leeds & Northrup Co.

8—REGENERATION METHOD improves effluent quality

The FBR Regeneration Method (for fixed bed reverse flow) is claimed to result in lower electrolyte leakage, greater uniformity of effluent and reduced operating cost. It consists basically of a means of flowing regenerant up instead of down while maintaining a fixed, rigid resin bed which prevents channeling or short-circuiting of regenerant solution. By pumping acid up through bed, band of resin richest in hydrogen is at bottom which is the point the water being treated touches last before leaving unit. This rich band becomes a scrubber zone and reduces leakage so that a purer effluent is produced. Chief use of FBR is with high

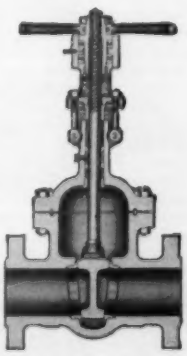
Replaced leaking valves with Crane gates
No leaks...no maintenance...in 2 years

New gate valves, installed on steam lines to and from a fire-watch pump at a gasoline plant, leaked continually, almost from the day they were installed.

When frequent maintenance failed to stop the leaks, Crane steel wedge disc gates were installed. One valve was a 3-inch, 300-pound No. 33XR; the other one, a 4-inch, 150-pound No. 47XR—both rated for steam service at a maximum temperature of 850° F. Both valves have Exelloy discs and stems, and replaceable No. 49 Nickel Alloy, screwed-in body seat rings.

The switch to Crane valves was made two years ago. Since then, they have been in continuous operation. Not *one* leak has developed—and not *one* cent has been spent for maintenance.

Get the jump on your costly maintenance problems. Make original as well as replacement installations with Crane valves and other piping materials. For all facts about the many Crane valves used for refinery, pipeline and other services, see your Crane Representative or write to the address below.



Typical cross section of Crane steel wedge disc gate valves widely used in refinery, power and process services. Available in sizes up to 48 inches; for oil or oil vapor, steam, air, gas, gasoline, water and other services. In seven pressure classes—150-pound to 2500-pound, with temperatures to 1100°F. Choice of trim materials is most complete. Write for details.

CRANE® VALVES & FITTINGS

PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

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solids waters to get purest effluent possible, but there are advantages in using it in connection with low solids water where it may permit reduction in equipment. Graver Water Conditioning Co.

9—TUBING INSULATION stops condensation on cold lines

Now in slip-on form, Clocel Tubing Insulation is designed to stop condensation on cold lines and provide excellent thermal insulation for copper tubing carrying hot, cold, or chilled water, or other liquids or gases. K factor of this closed

cellular nitrogen-filled insulation is given as 0.28 at 75 F, and is said to remain constant throughout the life of the product. Effective temperature range is 0 to 200 F. This tubing resists water and moisture indefinitely, while providing the thermal qualities of entrapped nitrogen, says manufacturer, and its light weight and soft resiliency make it easy to install — you slip it over fittings and seal with suitable adhesive at joints. Clocel comes in standard copper tubing sizes from ⅜ to 3⅛ in. ID. Five wall thicknesses range from 1/16 to ¾ in. Insul-Coustic Corp.

11—FREQUENCY RECORDER is narrow-range instrument

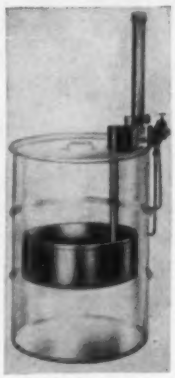
For industrial and other applications demanding close frequency checks, this instrument is announced as featuring a 58 to 62 cycle range, accuracy of ± 0.05 cycles, and self-contained construction. According to manufacturer, expanding the instrument's scale — calibrating a standard 6-in. record roll for only four cycles rather than 10 — achieves higher recording accuracy and greater chart reliability. Available for compact semi-flush or surface panel mounting or as a portable instrument, this recorder uses no external impedor. Elimination of this component and associated mounting and wiring lowers installation time and costs, it is noted; similarly, hook-up time is reduced when using the portable version. The recorder incorporates throw-away inkwell, 150-ft record roll, multiple chart speeds, chart supply indicator and fluorescent-lighted chart face. It is also available for 50- or 25-cycle applications. General Electric Co.

12—BTU METER for use with central air conditioning

This low priced mechanical Btu meter, Model 200, accounts for refrigeration or heating furnished by central air conditioning systems using chilled or hot water. It multiplies temperature change of the water by the flow and two counters register the heat transferred and the water flow. Indication of differential temperature is provided. This meter may be located up to 10 ft away from the flow measuring element, in a position convenient for reading and checking. Any water volume above 0.25 gpm can be metered. Prices start around $550.00 Data Sheet 200-MR1 gives further details. American Meter Co.

13—AGITATING DEVICE cleans parts efficiently, economically

An air-powered, mechanically agitating device for attaching to a 55- or 30-gal drum, or still tank, the Porto-Lif converts the drum into a parts cleaning unit. Designed for limited-budget applications, the Porto-Lif employs the same principle of mechanical agitation used by company's Aja-Dip and Aja-Lif cleaning machines. A single lever controls the cleaning operation. A flick of this lever lowered the platform of dirty parts into the cleaning solution, another flick agitates the parts in the solution (140 up-down motions per minute), and a third movement of the lever raises the work out of the liquid. The Porto-Lif operates on air pressure from 30 to 90 psi. Manufacturer says 75 lb of work can be cleaned at a time. Magnus Chemical Co., Inc.



14—VIBRATION DAMPERS curb pipeline shakes, noise

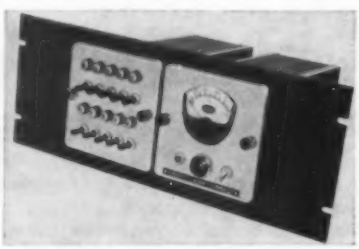
Stainless steel Allflex Vibration Tamers are claimed to remove excessive vibration and dampen noise in pipeline applications and smooth out pulsations of force pump systems. The units are rated to 15,000 psi burst pressure, temperatures to 1500 F. Scale formation is minimized while handling exhaust, superheated steam, gas or oils at extreme temperatures, says manufacturer, and stainless steel's corrosion resistance makes these units suitable for chemical conduction. Standard units include tube or pipe ends, for brazing or welding unto tubing or pipelines, as well as threaded and/or flanged ends. They come in standard pipe sizes from ¼ through 12 in. Allied Metal Hose Co.

10—MONITORING SYSTEM checks many temperatures

For monitoring a virtually unlimited number of points continuously, this compact thermistor-type system is designed to detect and warn when temperature at any protected point reaches a preselected limit. It can monitor temperatures between −25 and 600 F. Sensing circuits, which use no sampling or scanning devices, are terminated in a multiple-channel bridge network which receives and monitors inputs simultaneously and continuously.

The system is designed around two types of modular units: a monitoring module which handles inputs from a group of 10 sensing points; and an alarm-indicator module containing amplifier, temperature indicator, alarm circuit and connections for secondary switching or control functions required during an alarm condition. Each alarm-indicator module can handle inputs from 10 monitoring modules, representing a capacity of 100 sensing points per amplifier. The system can be supplied to detect temperatures: above a pre-set limit; below a pre-set limit; out-of-band between upper and lower limits.

Two amplifier types are available. For normal applications, a transistorized amplifier is furnished; for extraordinary service conditions, a hermetically sealed magnetic amplifier can be supplied. At present, the system is available only with manual means for identifying and indicating the temperature of the trou-



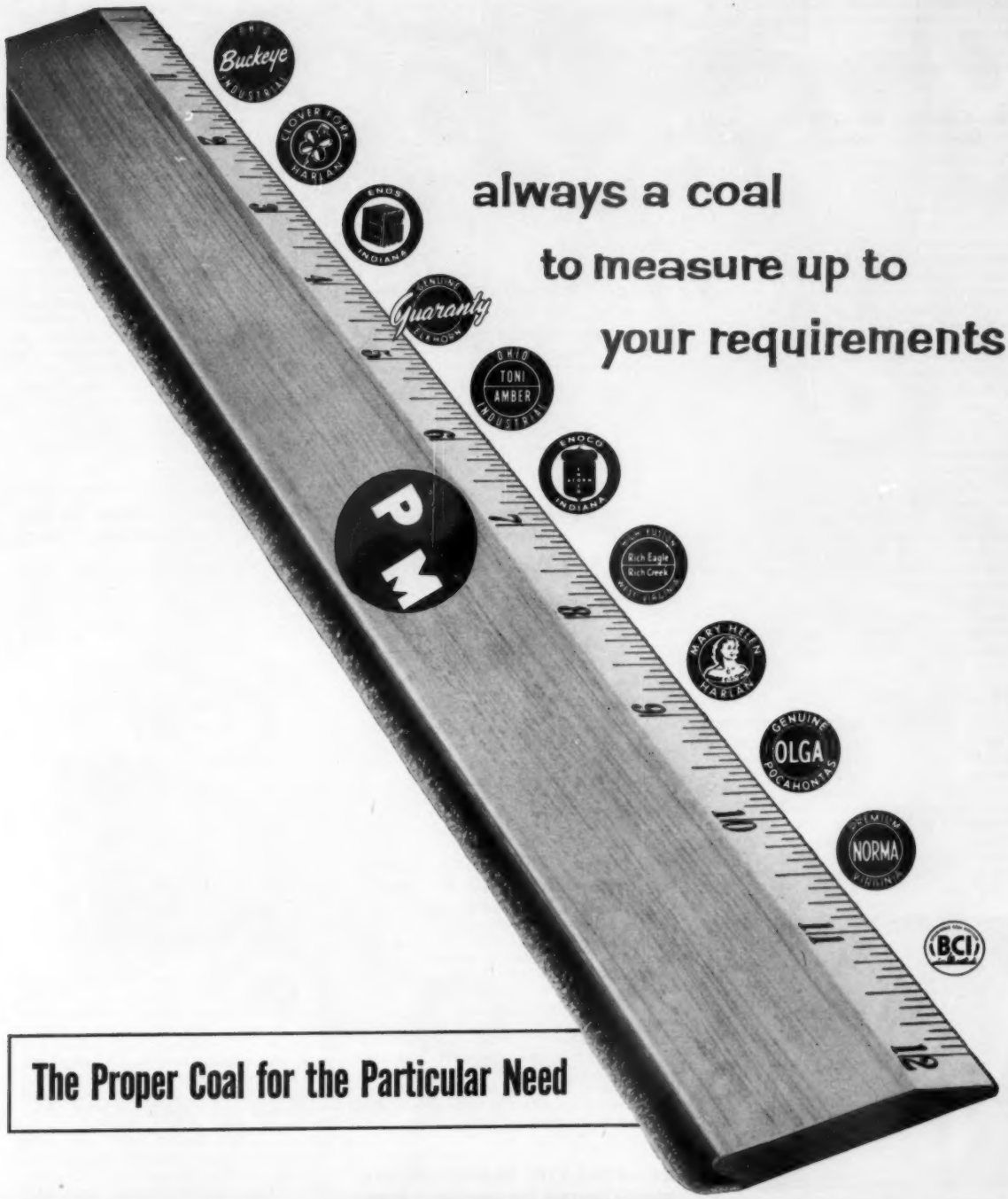
ble point. In operation, the input from each group of 10 probes is fed to the monitor module. Whenever the electrical resistance of any thermistor probe reaches an abnormal value (representing an abnormal temperature) it causes an unbalance in the associated channel of the bridge network and produces the current which is amplified in the alarm-indicator module to actuate the alarm circuit. The alarm condition is signalled by a light on the alarm indicator module, plus associated warning devices. The amplified alarm signal can also initiate protective measures. You find the trouble point by switching each sensing probe successively into the temperature indicating circuit.

The system operates on 60 cycles, 110 or 220 v input; the alarm system is rated at 5 amp. Manufacturer says the cost is equal to or lower than other presently available systems — continuous or scanning — and that maintenance costs should be lower. Fenwal, Inc.

15—PACKAGED BOILER for high temp hot water use

In the Flo-Kontrold, water is circulated at temperatures between 250 and 450 F with system loads from 4 to 100 million Btu/hr, it is announced; yet this packaged boiler is basically simple, covers a wide range of load requirements and requires only minimum maintenance. Circuits are arranged to eliminate possibility of vapor locking as there are no reverse vertical down flow tube circuits. All circuits are drainable at one point through the bottom header, and vented at one point through the top header.

The Flo-Kontrold is supported on a structural steel frame and enclosed with a welded steel casing, designed gas-tight for pressurized furnace firing. No special foundation or brick supporting construction is required, says manufacturer. Circulating pumps are optional equipment as pressure drop through boiler is from 10 to 15 psi under normal operating conditions. System make-up water is reportedly only a fraction of 1 per cent — make-up water is handled with a minimum of auxiliary equipment.



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Serving Industry Since 1883

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Specifically developed for high temperature hot water heating or process work, the Flo-Kontrold may be fired with oil, gas or combination oil/gas, or coal. Boiler Engineering & Supply Co., Inc.

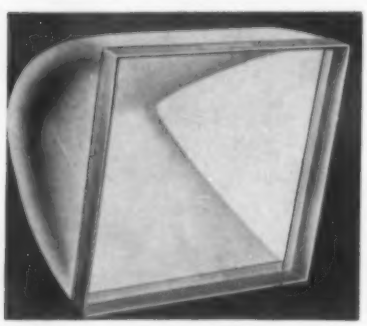
16—CHART RECORDERS with electric or pneumatic controls

These circular chart recorder-controllers are announced as incorporating company's D-Pak constant voltage supply unit which eliminates batteries, standard cells, and standardizing mechanisms in potentiometers. They also feature interchangeable slide-wires, replaceable range standards, plug-in amplifiers, recessed indicator pointers to facilitate chart replacements, as well as rigidly supported scales on back of plate assembly to permit easy calibration and indicator readings with the door open.

Pneumatic controls in Models 6836 (potentiometer) and 6856 (Wheatstone bridge) are available as universal controller, proportional plus automatic reset, or proportional with such automatic reset and derivative; proportional band adjustability — 2 to 300 per cent. Electric controls in Models 6833 (potentiometer) and 6853 (Wheatstone bridge) are available as contact type (two- or three-position) and proportioning control with 5, 10 or 20 per cent proportional band. The null-balancing type recorders are for a-c operation only; 115 v, 60 cycles; or 115, 50 cycles. Seven standard chart speeds range from 7 days to 1 hour per revolution. Daystrom-Weston Industrial Div., Daystrom, Inc.

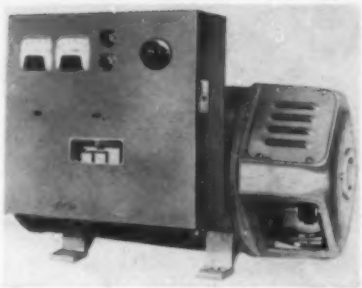
17—BAG TYPE FILTER is disposable, parabolic shaped

The Arco B/T Pure-Air Filter is reported to offer higher air-cleaning efficiency, greater dust-holding capacity and low initial resistance at a modest cost. It is described as the first parabolic shaped disposable bag type filter specifically engineered for air-conditioning, heating and ventilating systems. Filtering action is strongest where dust particles are finest; air flow is strongest



where accumulation of large dust particles is greatest. Least resistance to air flow is at the back of the bag.

The filtering material has upstanding fibers on its surface, which help to promote formation of a pervious filter cake. As this builds up, the air stream hits it at an angle, breaks it off and carries it to the back of the bag. Among advantages claimed for this filter are adaptability to low or high velocity systems, simple and economical installation. Due to the filter's light weight, supporting or loading devices aren't required. Standard sizes are available. Arco Mfg. Corp.



18—BATTERY CHARGERS offer both cost and space savings

These constant-voltage battery chargers with generators, motor and control panel in one unit are reported to save up to 42 per cent in cost and 34 per cent in required floor space over comparable models with separately mounted components. For switchgear, emergency power and lighting, and other applications, they utilize a diverter-pole armature design in which series-wound intermediate poles and magnetic bridges between main shunt-wound poles compensate for load changes to maintain — without external regulators — constant voltage from zero to full load. Electrical loads beyond the safe capacity of the generator are shifted automatically to the battery, it is explained; when the load drops back within normal range, the diverter pole charger reassumes the load and recharges the battery.

The new models save on cost because they eliminate necessity of installation and connecting separate motor-generator and control panel components. Most models do not require special mounting foundations. Also with controls mounted on the unit, the control panel need not conform physically to standard switchboard installations. Floor space savings are possible because these chargers do not require walk-space between panel and motor-generator for servicing. Seven sizes are available with ratings from 1 to 10 kw, rotating speeds of 1800 or 1200 rpm. Form 6261 gives full information. Exide Industrial Div., The Electric Storage Battery Co.

19—PAINT preserves wood as well as metal surfaces

Due to the addition of a fungicide, DDBACC, this improved Rustrem is said to form a tough, attractive finish that protects wood surfaces against rotting, fungus growth, moisture, chemicals, mild acids and fumes. It is claimed particularly applicable for use where metal and wood are fastened together or come in contact. Selection of standard colors includes black, super aluminum with clear base, aluminum with black base, red, green, gray, white; other colors can be ordered. The paint needs no prime coating and can be brushed or sprayed on. Form RAR-1 gives details. Speco, Inc.

20—LIQUID CHEMICAL FEEDER operates at low flow rates

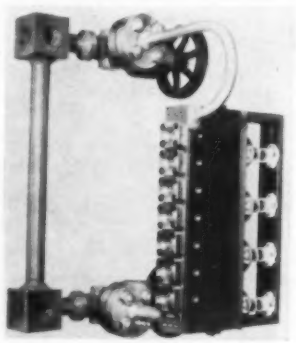
The Micro-H is designed to meter, regulate and feed liquid chemicals continuously at flow rates from 0.1 to 4 gal per day into a liquid stream. Semi-automatic, the Micro-H has a built-in ejector, plastic body and porous stone to feed the liquid chemical. The latter must be free of suspended solids and should possess sufficient transparency to permit the scale to be seen. The unit is intended for use with hypochlorite solutions, defoaming agents, rust and scale inhibitors, slime control agents etc. Fischer & Porter Co.

21—POLE-TYPE TRANSFORMERS, plastic coated, for corrosive areas

Plastic-coated pole-type transformers in standard ratings are introduced for use in areas where environmental conditions are severe. The finish is suggested for applications where the atmosphere is contaminated with salt, chemical fumes, or dust and sand. It is described as corrosion-resistant, mechanically strong, hard wearing and good looking. Previously announced by this manufacturer, a plastic-coated cover for transformers with cover mounted bushings, using a different plastic provides insulation against line-lockout from birds and squirrels. Westinghouse Electric Corp.

22—WATER LEVEL GAGE for the medium pressure boilers

Although similar to manufacturer's high pressure model, this Yarway Color-Port Water Level Gage is designed specifically for boilers operating at pressures to 1050 lb WSP. Design is individual port



type, with cover plate assemblies that can be readily serviced or replaced with the gage in place. Spring loading maintains proper pressure on the sealing gasket at all times, company states, and port assemblies are interchangeable. The Color-Port gives brilliant two-color readings — steam showing red, water showing green. A full gage is all green, an empty one, all red. Ranges of visibility available are 13, 15½ and 18 in. Illuminators give greatest intensity of light in middle of each port. Bulletin WG-1815 gives data. Yarnall-Waring Co.

23—FANS feature high volume, low space requirements

Forward curved mechanical draft fans, designed to provide a high air movement to size ratio, are offered for heavy-duty induced draft operation. Economical first cost, high operating performance and quiet operation are reported for them. By using a large number of forward curved blades, fans can handle large volumes of air or gas within minimum space requirements. Blades are mild or alloy steel, depending on duty,

look
what's
new
in

metering pumps

new streamlined safety shield
new crank-type design
new improved accuracy
new parts interchangeability
new operational efficiency
new maintenance ease

all for a new lower price

Send for new booklet giving the biggest news in pumps...

See how the all-new Hills-McCanna Masterline metering pump can bring you new highs in economy and performance. This booklet tells the story . . . gives you the details on the pumps that go new *inside* and *outside* to register all-time highs in accuracy, dependability and maintenance ease.

Ask for Bulletin #900 "Look What's New in Metering Pumps". . . it pinpoints the features that make Masterline pumps your best buy for now and the *future!*

Hills-McCanna Company, 4620 W. Touhy Ave., Chicago 46, Ill.

hills-mccanna company

THE PEOPLE WHO KNOW AND CONTROL FLOW

For more data circle 549 on Post Card

low furnace high safety

Cleaver-Brooks updraft design keeps hottest gases low in the boiler. Greater safety and drier steam

UPDRAFT CONSTRUCTION — with low furnace — in Cleaver-Brooks boilers provides greatest margin of operating safety. Hottest gases are low in boiler . . . for greatest submergence. The 4th pass of gas travel — with low temperature gas — is closest to normal water level. This means greatest safety in case water level drops. Updraft construction is one of the four DESIGN STANDARDS that make Cleaver-Brooks your best packaged boiler buy.

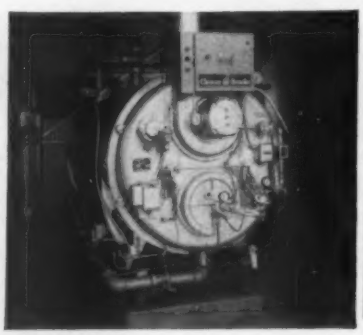
4-PASS FIRE TUBE DESIGN maintains high flue-gas velocity to provide optimum heat transfer for low cost steam or hot water.

FORCED DRAFT — supplies controlled quantities of cool, clean boiler room air. Cleaver-Brooks design assures proper air fuel ratios necessary for complete combustion. Eliminates high chimney.

5 SQ. FT. OF HEAT TRANSFER SURFACE — for each boiler hp is the greatest amount offered in any packaged boiler. It's your assurance of longer boiler life, lower fuel costs, less boiler maintenance.

This exclusive combination of DESIGN STANDARDS is the basic reason for the clear superiority of Cleaver-Brooks packaged boilers, 15 to 600 hp; 19 sizes, 130 models; steam or hot water; oil, gas or combination oil/gas fired.

For detailed data, write Cleaver-Brooks Company, Dept. F, 311 E. Keefe Ave., Milwaukee 12, Wis.



Cleaver Brooks®

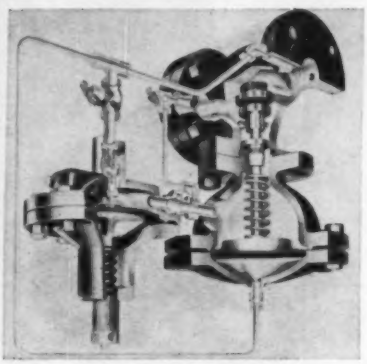
ORIGINATOR AND LARGEST PRODUCER OF PACKAGED BOILERS

For more data circle 550 on Post Card

and housings are braced, continuous-weld heavy steel plate. Contributing to quiet operation are low speed rotor operation; streamlined inlets to direct air into the rotor with minimum turbulence; and oversized inlet boxes to reduce entering velocity, provide good air distribution to the wheel. Inlet vane controls may be manual or automatic. There are 16 wheel diameters; outlet duct sizes vary from 18 to 77 in., and two speed ranges are available. Fans may be used with direct motor connections. Chicago Blower Corp.

24—PRESSURE REDUCING VALVE is pilot operated, compact

In addition to accurate control of a pilot operated valve, the Class AD Valve is claimed to offer ready installation, space saving and mounting flexibility. It will control compressible and incompressible fluids — steam, water, gas, oil, air — without change in design, and since all piping connections are fabricated within the flanges of the main valve, the unit is ready to bolt in place. This compact valve is self-contained and packless, designed to sense and activate directly from main valve flanges. Either pilot or

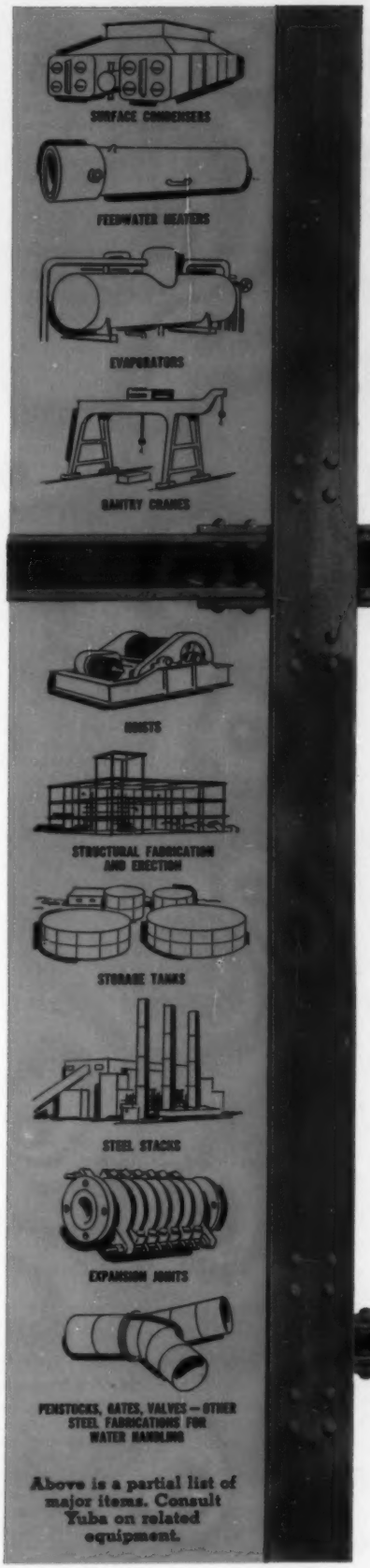


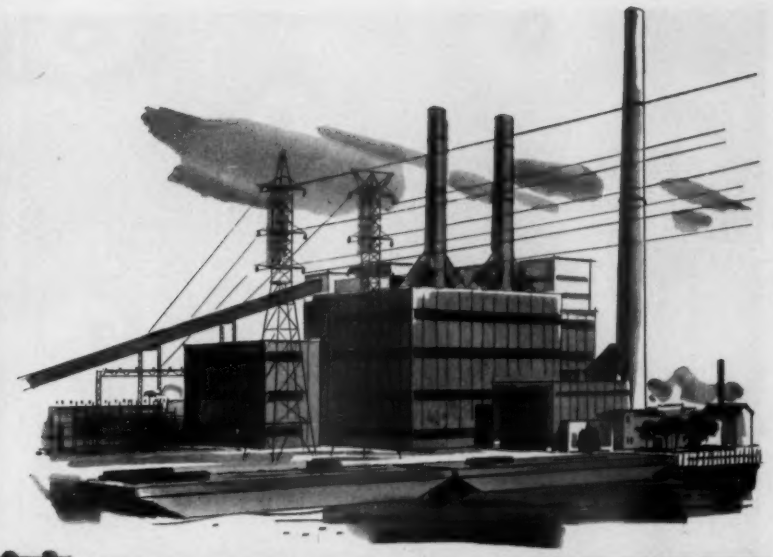
main valve may be installed in any position convenient to piping system.

Reduced pressures adjustable between 0 and 125 psig can be secured from use of one of three springs, interchangeable without removing valve from service. The single seated valve is designed to provide full port opening or dead-end closing, or modulate to degree of opening necessary for precise downstream pressure control on continuous demand. Dead-end closing force is secured by utilizing full upstream high pressure magnified by diaphragm area. Wide one-step reductions (600 to 1 psig or intermediate pressures) can be made, if desired. The C. E. Squires Co.

25—SMALL DEIONIZER with resin refill service

The Junior 120 delivers up to 120 gal of deionized water per hour and is intended for applications which do not justify a large deionizer, but are too great for portable or cartridge unit capacities — as in laboratories, smaller industrial plants. For these, the compact (45 in. high) unit provides water claimed freer from mineral impurities than distilled water, and at a fraction of the cost of distillation. It delivers between 6300 and 8400 grains exchange or up to 1500 gal per cycle. No regeneration is necessary. Included with the Junior 120 is a service





LOOK WHAT YUBA MAKES FOR STEAM POWER PLANTS

Electric utilities planning construction of a new steam plant or expansion of present facilities, look to Yuba as a dependable, fully integrated source for all the varied equipment shown here. And for all the skilled services related to its design, engineering, installation or field erection.

Operating nationwide, the divisions and manufacturing plants of Yuba serving the power industry are ideally located to serve you better, providing a single-company responsibility so important in meeting highest product quality standards and delivery requirements — economically.

Your inquiries on any or all of these products or services will receive our prompt and careful attention.

DIVISIONS AND SUBSIDIARIES SERVING THE POWER INDUSTRY: *YUBA HEAT TRANSFER DIVISION, Honesdale, Pa. • ADSCO DIVISION, Buffalo, N.Y. • YUBA MANUFACTURING DIVISION, Benicia, Calif. • SOUTHWEST WELDING & MANUFACTURING DIVISION, Alhambra, Calif. • JUDSON PACIFIC-MURPHY DIVISION, Emeryville, Calif. • YUBA CONSOLIDATED ERECTORS, INC., San Francisco, Calif.*

YUBA

YUBA CONSOLIDATED INDUSTRIES, INC.

351 California St., San Francisco, Calif.

Plants and Sales Offices NATIONWIDE

For more data circle 551 on Post Card

whereby removable bags of mixed ion exchange resin, when exhausted, are lifted out and exchanged for factory regenerated refills. A built-in ohm meter actuates a pilot signal when effluent resistance falls below 50,000 ohms. Spent material is then replaced with fresh ion exchange resin which the user keeps on hand. Bulletin 513 gives details. Elgin Softener Corp.

26—TEST SET comes in portable, bench models

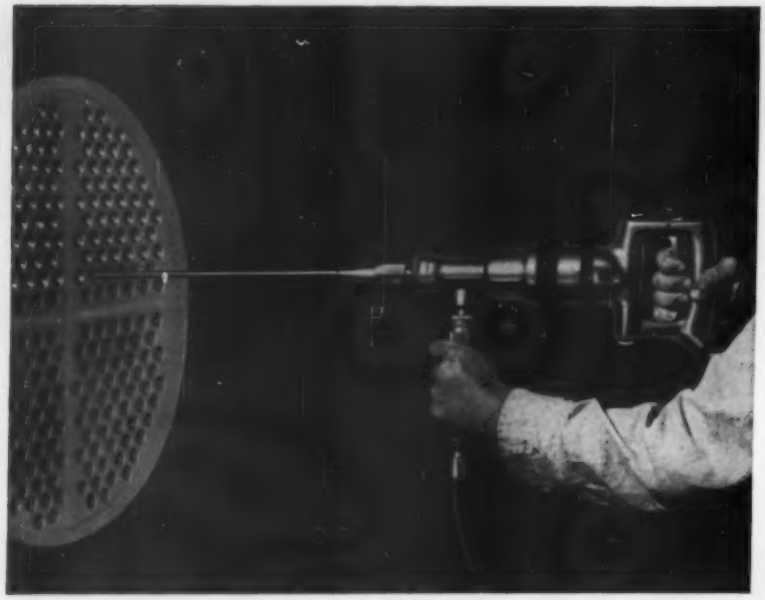
This dielectric test set, 5 kv, 1 ma, with maximum output current 5 ma at output voltage up to 2.5 kv, is for step-voltage resistance tests on insulation in electrical equipment with voltage ratings in

the 300, 600 and 2500 v classes. Applications include rotating electrical machinery, dry-type transformers, switchgear, capacitors and insulators rated 230, 440, 550 and 2500 v a-c and d-c; traction motors and generators rated 600 v, and wiring installations and cable with smaller conductor sizes and Code- or heat-resistant insulation rated 600 v. The bench model (shown) is suggested for acceptance and proof test on electrical insulation systems for quality control in manufacturing and repair. The portable set, housed in a shock- and wear-resistant case, lends itself to severe field use for test of reconditioned equipment after installation, and in preventible maintenance of installed equipment. More details are given in Bulletin 22. James G. Biddle Co.

Described on these pages are new and improved products. Use Reader Service Cards on pages 129–130 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

27—BURNER for firing Scotch marine boilers

The Turbo-Flame Burner is designed for Scotch marine boilers where there is a known or possible back pressure or positive furnace pressure. Five standard models range from 1,000,000 to 5,000,000 Btu. Burner capacity is determined by back pressure developed in the furnace and the Model TF-1, for example, has a maximum capacity of 1,800,000 Btu with a 0.1-in. w.c. negative pressure or



One man handles this powerful Airetool tube cleaner...without a rig

There's no other tool like this Airetool Model CC-475 heat exchanger and condenser tube cleaner. It weighs just 10 lbs. One man handles it easily — without a supporting rig. Yet, it's powerful enough to clean all severely clogged tubes up to 1″ diameter. Built-in flushing system washes away debris, cools drill head — keeps work moving at a fast pace.

You get this same time and cost-saving performance from Airetool straight tube cleaners and pneumatic, as well as electric tube expansion control systems. Write for Bulletin 66. *The Airetool Mfg. Co., Springfield, Ohio*

BRANCH OFFICES:
New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge.

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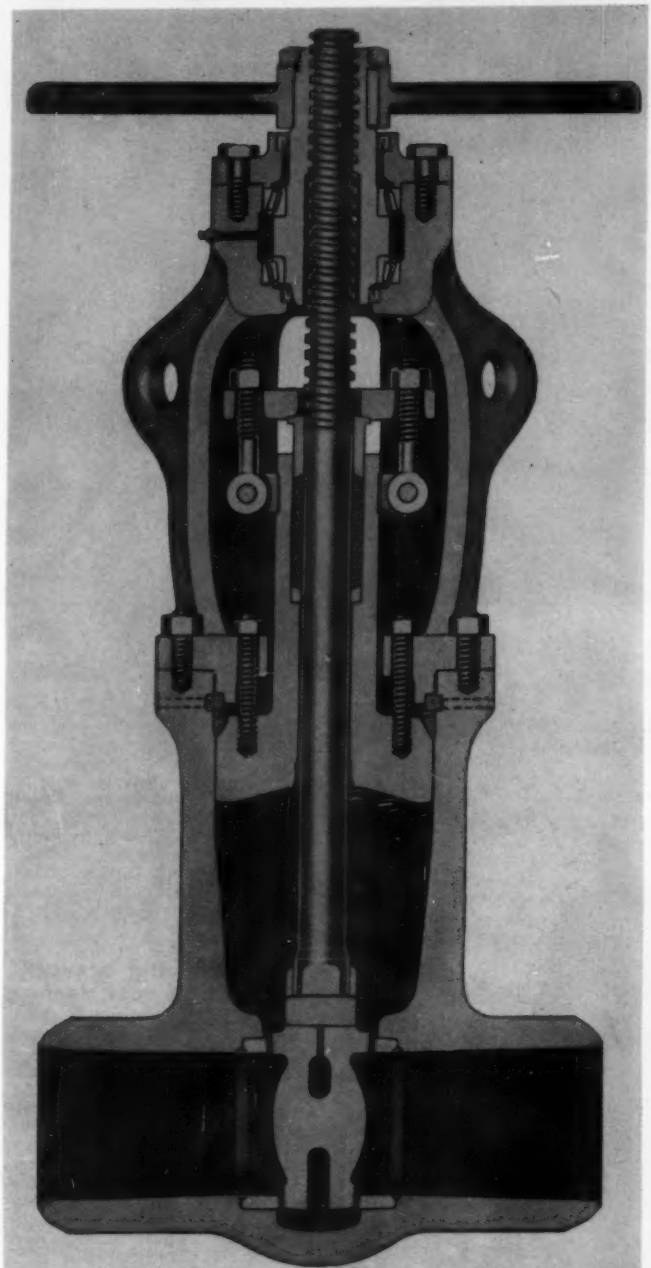
Here's the Ultimate in the Control of High Pressures, Temperatures...



Sectional view of 1500-pound Steel Pressure Seal Gate Valve. 600, 900 and 2500-pound valves are also available — in all commercial sizes.

Steel Pressure Seal Globe, Angle, and Check Valves are also included in the complete Powell Line.

POWELL PRESSURE SEAL VALVES

When Powell Steel Pressure Seal Valves are specified and installed on high pressure, high temperature lines you can be sure of top performance in controlling the flow of the fluids being handled.

Superior features of design and construction, many found only in Powell Valves, make this possible. For example:

- Sturdy studs hold the yoke to the body, eliminating the need of a heavy clamp, and maintaining perfect alignment and rigidity of yoke to the body.
- Stellite faced pack-under-pressure seat and stem guide insure tight sealing and accurate guiding of stem.
- Lifting lugs in yoke facilitate handling the valve during erection and maintenance, and provide means for supporting weight of the valve.
- The gasket can be removed without damaging the sealing surface of the body. The gasket seating surface in the body can be easily lapped, if required—an outstanding feature of Powell design.

These are a few of Powell proven features. There are others we'd like to tell you about. Write—or consult your nearby Powell distributor.

THE WM. POWELL COMPANY

Dependable Valves since 1846

Cincinnati 22, Ohio

BRONZE • IRON • STEEL

CORROSION RESISTANT METALS AND ALLOYS

POWELL...world's largest family of valves

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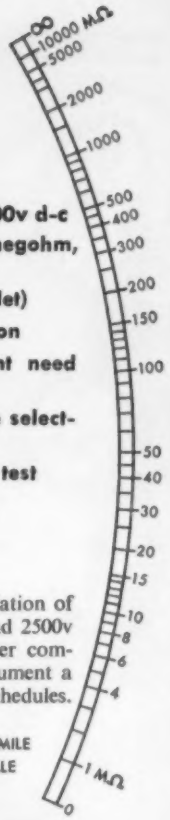
New MEGGER®
INSULATION TESTER

. . . 6-Voltages
. . . Rectifier Operated



FEATURES

- 6 output voltages 500, 750, 1000, 1500, 2000, 2500v d-c
- single scale, wide resistance range 0-10,000 megohm, easy to read
- rectifier-operated (plug-in to standard lighting outlet)
- excellent output voltage stabilization and regulation
- extremely rugged measuring system—instrument need not be leveled, fast indication
- single output voltage selector switch—no errors in selecting test voltage
- automatic discharge of tested insulation at end of test
- easily portable, moderate size and weight

APPLICATION

Ideal for making step-voltage resistance tests on the insulation of electrical equipment with voltage ratings in the 300, 600 and 2500v classes. Maintenance men in large industrial plants, power companies and railroad electrical repair shops find this instrument a real time saver where many tests must be made on tight schedules.

FACSIMILE SCALE

Write for BULLETIN 21-20a-PE

B608

JAMES G. BIDDLE CO.

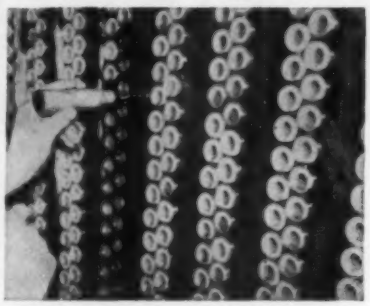
Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

For more data circle 554 on Post Card

draft. Common problems of firing Scotch marine-type boilers including pulsation, high-combustion chamber loading, etc., are claimed virtually eliminated by the Turbo-Flame design, claimed also to maintain excellent CO_2 levels and stack temperatures below previously attainable minimum. Burner is a single port nozzle mixing type, for straight gas, oil, or gas-oil combination firing applications. The Mettler Co., Inc.

28—CONDENSER TUBE INSERTS protect new and worn tubes

Alkaserts, of polyethylene plastic, for inlet-end protection of power plant steam condenser tubes, are now available for ¼ in. by 18 BWG, ⅞ in. by 18 BWG and 1 in. by 18 BWG sizes. In Standard Alkaserts, for new tubes, the length is designed to cover the critical area exposed to inlet erosion and is streamlined to eliminate restriction to water flow. It is feather edged to prevent step erosion at the inner end. Expanded Alkaserts, for insertion in slightly worn tubes, come in graduated sizes to match normal wear patterns. (A set



of "standards" can be furnished for establishing the wear pattern of worn tubes). Expanded Alkaserts are pushed in by hand until about 1 in. remains to be inserted. Then, as illustrated, a wood or Micarta "persuader" is inserted and the Alkasert tapped home with light mallet blows. Both styles of Alkaserts are adaptable to ferrule-type and flush-type tubes, including ferrule, flush-welded, rolled and trepanned tube sheet. Tennant Development Corp.

29—STRAINERS offer economy, low pressure drop, quick cleaning

These single-basket pipe line strainers are available from stock in five sizes from 2 to 6 in., with flanged connections, rated at 125 psig working pressure (cold). Bodies and covers are cast iron, and a ductile iron quick-opening cover clamp is provided on all but the largest size, which has a bolted-on cover. Standard basket construction is stainless steel plate with ⅛ in. perforations. For fine straining, baskets are available lined with five mesh stainless steel screens, in which case the support baskets have ¼-in. holes. SK Bulletin 9S-A gives data. Schutte and Koerting Co.

30—UNIT HEATER CONTROL is small, combination unit

Type CUH Combination Unit Heater Control, described as the smallest device of its type, combines in one enclosure a number of accessories. All equipment is mounted on the removable cover

rugged and weatherproof

ELLIOTT YR TURBINES

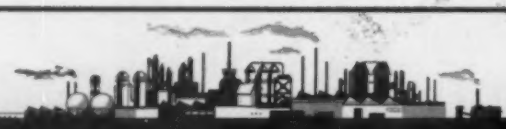
Desert heat, arctic cold, driving rain and swirling dust don't faze rugged, dependable Elliott YR Turbines. Tightly sealed against dust, fumes and moisture . . . built strong and husky . . . these machines make dependable, economical drives for pumps, compressors, fans, line shafts, generators and other equipment.

The governor is simple and reliable, and is available in several modifications to match speed and pressure control requirements. YR turbines are designed for easy installation and service. Many key parts are interchangeable for various frame sizes. Four sizes are shown at the right. Write for descriptive bulletin H22-C.

In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators through 44 mw.

ELLIOTT Company

JEANNETTE, PENNSYLVANIA H9-2

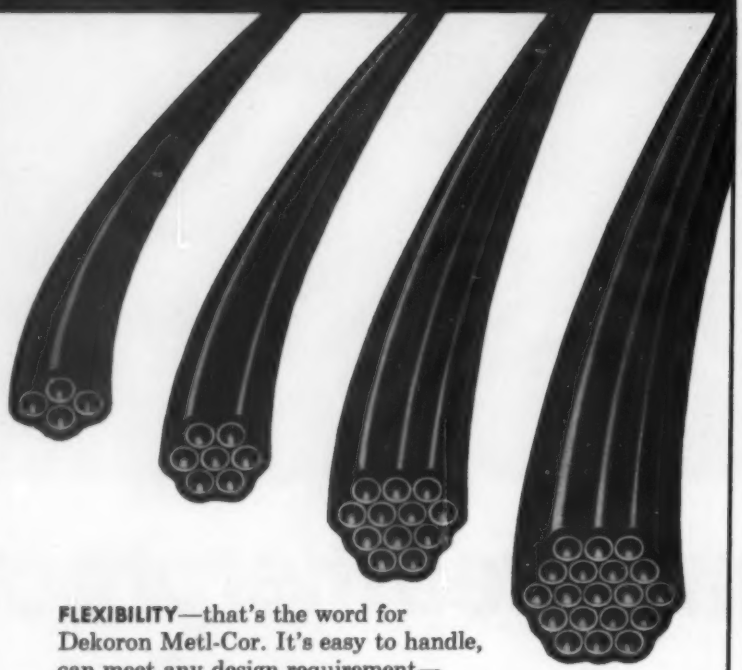


DEKORON METL-COR MULTIPLE TUBE HARNESS

cuts installation costs

bends without distortion

solves instrument line corrosion problems



FLEXIBILITY—that's the word for Dekoron Metl-Cor. It's easy to handle, can meet any design requirement—and it's highly corrosion resistant, too.

FIRST, Metl-Cor's exclusive Extru-Loc construction makes it easy to bend with no tube distortion.

SECOND, the Metl-Cor design is flexible. You can specify Metl-Cor with core tubes in either copper or aluminum . . . in any standard or special OD or wall thickness . . . with almost any number of tubes in each bundle.

MOST IMPORTANT, no matter which type or size you specify—you get all the inherent cost-cutting savings and longer life that you pay for. AA-7611

Dekoron® products
QUALITY · RESEARCH · SERVICE

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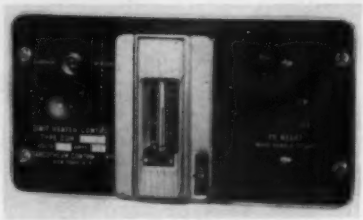


plate of a standard three-gang wall box to facilitate installation and wiring. The control may be wall- or flush-mounted by means of an adaptor furnished. Included in this control is a line voltage thermostat, manual starter with thermal overload protection, summer-and-winter switch light that permits fan operation alone in summer, pilot light indicator for fan operation, and terminal block accommodating line to service, fan motor, and optional low limit aquastat or pressure stat. Wall box is 8⅛ in. wide, 4½ in. high, 1⅝ in. deep. Sarcotherm Controls, Inc.

31—COUPLING DEVICE can join pipe in tight spaces

For joining pipe and tubing, especially where operational space is confined or where remote control operation is required, the Geartight Union consists primarily of a conventional coupling to which a gear and pinion locking mechanism has been added. This arrangement is useful where there is no room

to use a wrench at right angles to pipeline, although this method may be used when required. The pinion is removable from the coupling to make it tamper proof. It may be operated by a ratchet spanner, a gear key, or other remote control means. By turning the key or ratchet of the pinion, the gear nut rotates and the joint is tightened. Such rotation doesn't distort the pipe, it is stated, and the union always maintains a proper seal without being twisted out of shape, since the tightening force operates throughout the full 360 deg. Application shown permits access to control rod standpipes of a nuclear power reactor. Stanat Mfg. Co., Inc.

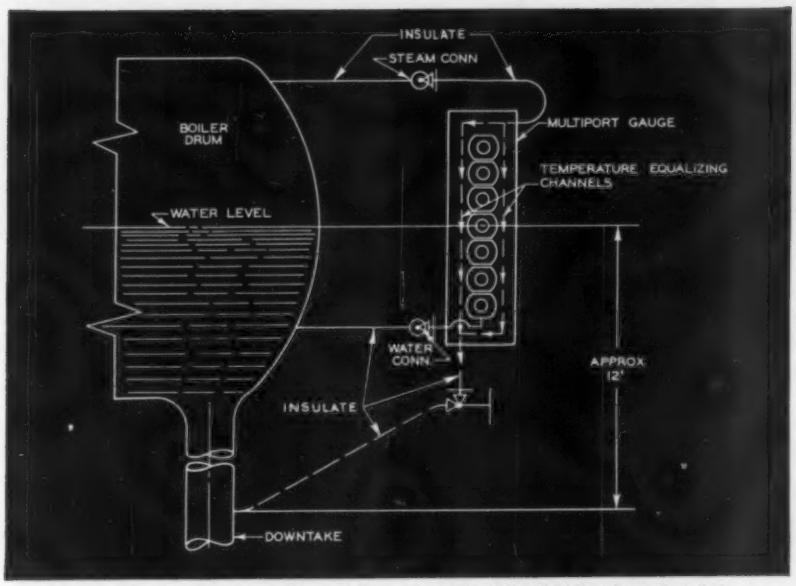
32—MIXING CONCEPT for epoxy resin compounds

Metalset A-4 now comes in a flexurally stronger version that is mixed on a simple one-for-one basis, whether by weight or volume. It is packaged in tubes of identical size — equal weight and volume — to facilitate mixing and reduce waste. The two tubes are in separate but

Diamond

Temperature Equalizing MULTI-PORT GAUGE*

Improves Accuracy of Water Level Indication at High Operating Pressures



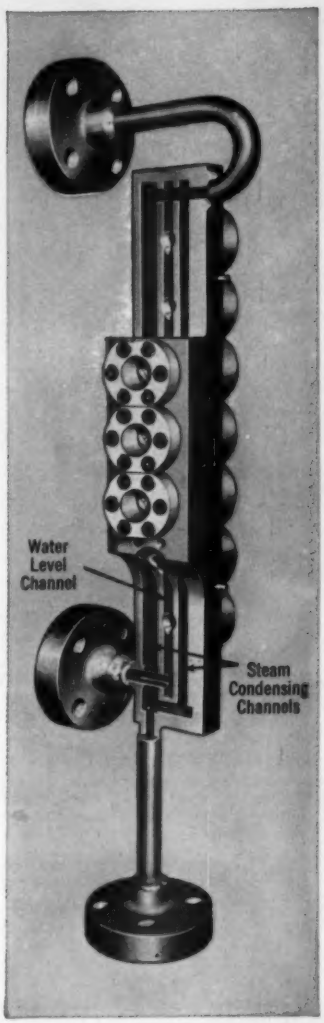
Diagramatic illustration of new Diamond Temperature-Equalizing Multi-Port Gauge installation.

By a simple reliable means the Diamond Temperature Equalizing Multi-Port Gauge* effectively reduces error in gauge level reading at high operating pressures.

Gauge error (resulting from the gauge temperature being lower than boiler saturation temperature) is substantially avoided by introducing supplementary gauge heating in the form of steam condensing channels. These channels are parallel to the gauge water level channel as illustrated, and serve to heat the gauge level channel by direct conduction of heat from condensing steam through the gauge body itself. No external source of energy or control is required. The heating channels have a natural circulation system independent of the gauge level channel so that no faulty operation can occur under any circumstance.

Ask your local Diamond office or write directly to Lancaster, Ohio for Form 2150 for further information.

*Patent Applied For.



Cut-away sections illustrate independent gauge body heating channels of the new Diamond Temperature-Equalizing Multi-Port Gauge.

DIAMOND POWER SPECIALTY CORP. 8274

LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED—Windsor, Ontario

For more data circle 557 on Post Card

How to Stop VIBRATION..

in

POWER and PROCESS PLANTS

Send for this New Catalog—
Save Engineering Time!
Cut Construction Costs!

BARCO
"Ball Type"
Flexible Struts

Use these pre-engineered load-carrying units that save time and cut costs on many piping design projects:

SIMPLE—Eliminate need for complicated structural designing or design of special struts, tie-rods, slides, or pin and clevis arrangements.

DOUBLE ACTING—Handle both tensile and compressive loads.

LOWER COST—Almost always lower in first cost and on a life-time basis. Often reduce need for structural steel.

SAFETY—High load carrying capacity, combined with easy calculation of proper sizes promotes safety in structural design.

PRECISION BUILT—Factory machined to close tolerances and rigidly inspected. Reduces possibility of dangerous errors in field construction. Lubricated for life.

"VIBRASNUB"
Hydraulic
Vibration Snubbers

Immediately available from stock and readily adaptable to economical field use for handling rapid shock loads and restricting vibration in hot piping. Typical applications are in high temperature piping in steam plants, petroleum refineries, and process plants. The "Vibrasnub" readily allows thermal movements, but effectively restricts rapid vibration movements and momentary shock loads such as may cause dangerous stresses, annoying noise, or deterioration in structural assemblies. "Vibrasnubs" work where spring-type dampners or shock absorbers will not permit required movement. Barco can provide engineering data for solution of many vibration problems. Ask for information.

SEND FOR NEW CATALOG 229A—Illustrated with drawings and photographs showing how to reduce design engineering time and save on structural costs with new Barco "Ball Type" Flexible Struts and "Vibrasnub" Hydraulic Vibration Snubbers.

PRODUCTS BACKED BY EXPERIENCE
BARCO
FOUNDED 1900

BARCO MANUFACTURING CO.
547F Hough Street • Barrington, Illinois

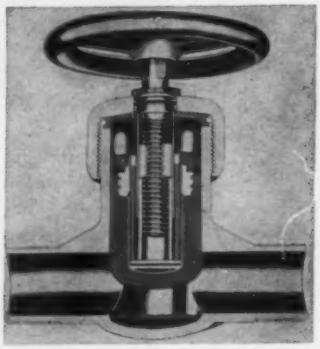
Flexible Joints • Structural Products • Construction Equipment
In Canada: The Holden Co., Ltd., Montreal

For more data circle 558 on Post Card

attached containers of the same size, a visual reminder that mixing is done by squeezing equal amounts from tubes. You mix only what you need for the application. Smooth-On Mfg. Co.

33—PLASTIC VALVE is designed for tight sealing

In this plastic valve, employing a telescopic arrangement instead of a diaphragm, a soft rubber cup is forced to the concave bottom of the passage. Because of its flexibility, the cup under pressure from the stem, seals on all sides against the walls of the body casing, shutting off fluid flow. On the upper part of the shut-off body is a lipped packing to prevent fluid from contacting the stem or leaking out of the valve. The

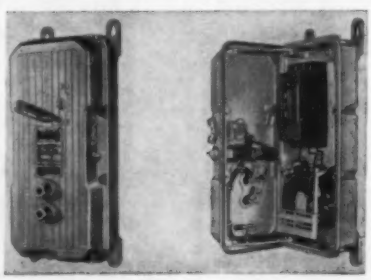


stem is in two telescope type sleeves which slide inside each other, the outer one acting simultaneously as a pressure tube in the plunger, reinforcing the rubber cup from within. Material flowing through the passage under pressure is not forced out to the side during closure, it is explained, and thus, even under maximum pressure, the cup locates in the position provided in the passage.

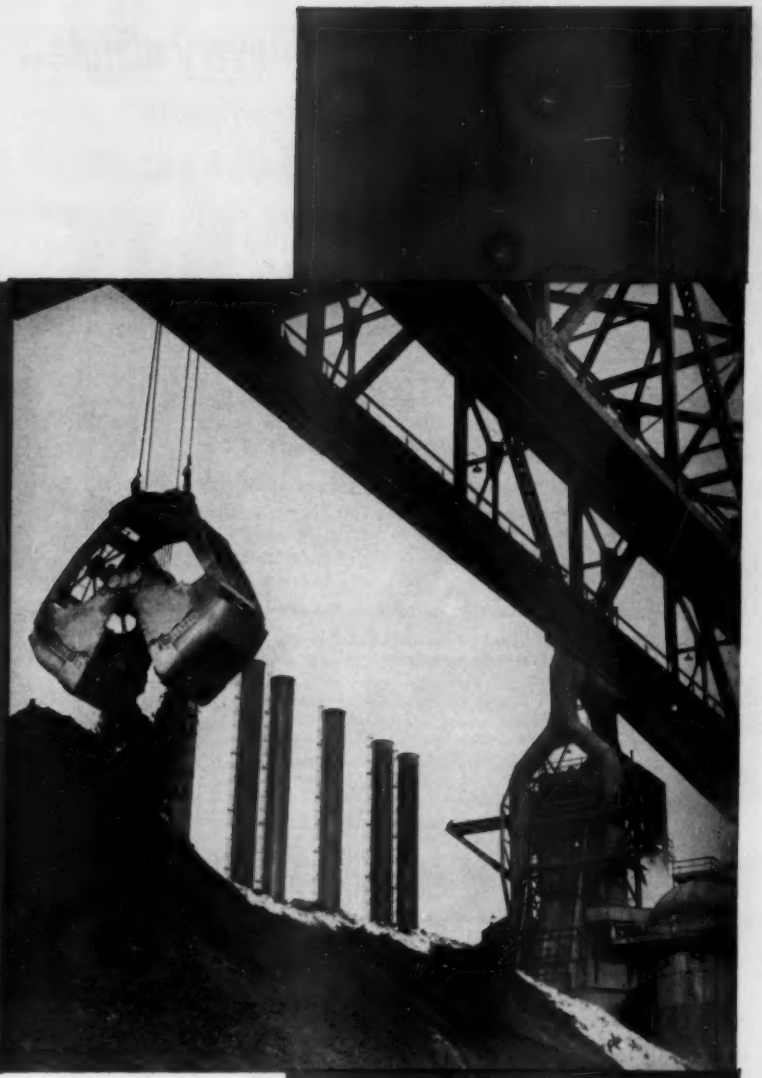
Foreign matter in the line does not impair the valve because the soft rubber cup is flexible enough to accommodate these particles without damage to itself or affecting its sealing characteristics. Valve body, cover, handwheel and soft rubber cup can be supplied in plastic materials suited to the materials handled. Working pressure is 145 psi, sizes from 1 to 4 in. W. S. Rockwell Co.

34—CONDUIT FITTINGS for starters, circuit breakers

Combination line starter Condulets Type DMC (dust-ignition-proof) and Type WMC (watertight, illustrated) basically the same except for body and cover mating surfaces. These Condulets are designed to accept and operate any make of motor starters and circuit breakers. Single-speed non-reversing



Why Mead-Morrison Coal and Ore Buckets move more material



Mead-Morrison buckets are constructed almost exclusively of lightweight, high-tensile alloy steel that provides maximum payload per pound of bucket weight, less load on the structure, lower power consumption and high resistance to abuse.

They are designed for greater ease of penetration and digging power.

Low maintenance results from design and proper use of high strength material in the bucket. Its riveted—not welded—construction maintains proper shell contour and correct alignment and facilitates field repairs.

A new patented, *non-jamming* jaw linkage is available that obsoletes all other hinge types in the handling of non-crushable material.

The next time you are considering replacing a bucket remember that *the bucket moves the material.* Cheap, heavy buckets down-rate your entire system. The higher capacity per pound of bucket weight and the strength of Mead-Morrison buckets guarantee that your overall system is operating at maximum efficiency.

For detailed literature on Mead-Morrison buckets write to: . . .

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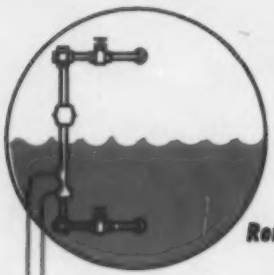
Know all your water levels—*every minute*—



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Remote indication saves time—increases safety

Any water-containing vessel is a potential hazard, whether it's fired or unfired. For most efficient control, *gages for all vessels should be out in the open, or at control stations.*

Where remote reading gages should be used:

Stationary power boilers
Feed water heater tanks
Waste heat boilers
Surge tanks
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Marine power boilers

What you should expect in a remote reading water level indicator	Reliance EYE-HYE
Flexibility of placement. Gage reading precisely where most convenient to use — even above the boiler.	✓
Sharp visibility. Easy to read green indicating fluid, illuminated.	✓
Scientific accuracy. U tube manometer principle for laboratory exactness.	✓
Simplicity. Smooth hydrostatic action — no mechanical working parts.	✓
Safety. Invites frequent reading — an aid to preventing water level accidents.	✓
Easy installation. Flexible tubes from boiler to gage window.	✓
Low maintenance. Scheduled cleaning only at infrequent intervals. Easy to blow down.	✓

Write for Bulletin CO and learn how EYE-HYE can increase the reading efficiency of all your liquid levels.

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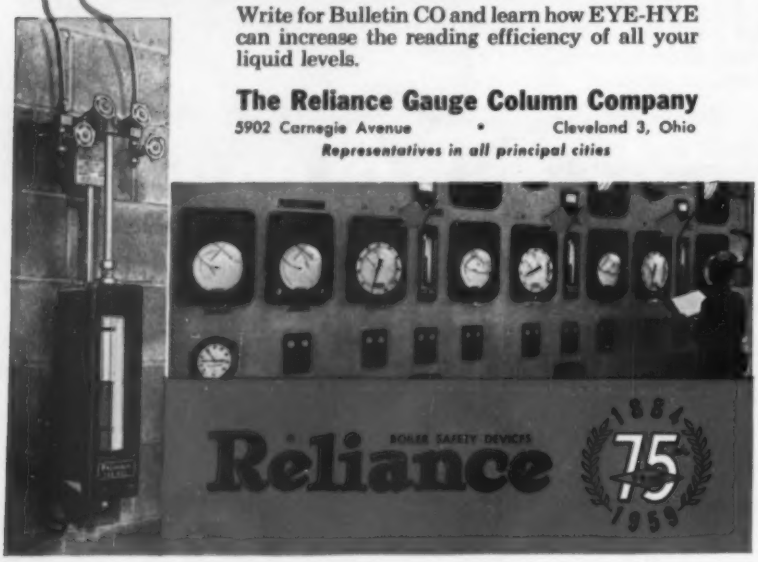

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combinations have a universal mounting plate, motor starter reset assembly and circuit breaker operating assembly. No substitutions of parts are required. The mounting plate is fastened to the back of the Condulet body with a knurled and slotted bolt in the center of the plate, facilitating removal of complete plate or starter or circuit breaker individually. Built-in push-button stations and selector switches etc. can be supplied. Crouse-Hinds Co.

35—A-C TEST SETS for use in dielectric testing

These high voltage a-c test sets are designed for dielectric testing of all types of electrical apparatus. Self-contained in an upright all-steel cabinet, test sets are available in four standard ratings, 20,000 to 50,000 v and 2 kva.

A control panel is located at arm height on a sloping front area at top of each unit. The devices use an oil-filled, corona-free transformer, a safety contactor in addition to a magnetic circuit breaker, and are push-button operated. General Electric Co.

36—PLUG VALVE is non-lubricated, general purpose type

The Wedgeplug O-Seal Valve, with two Teflon O-rings in the face of the plug, is claimed to double-block and bleed in most services to do the job of two conventional valves or a line blind. The valve is non-lubricated and the pressure sealing effect of the O-rings provides shut-off that remains bubble tight, according to manufacturer. Also announced for this steel valve are quick and easy operation, protected seats, double seating for safety, and no product contamination.

Because of the double pressure-sealing effect of the O-rings, the upstream as well as the downstream seats hold tight against line pressure, it is stated, and the bottom drain plug can be pulled to provide the tell-tale bleed. The valve is suggested for air, gas, water, steam, propane, hydrocarbons and other services, for temperatures from −300 to 400 F, not exceeding 720 psi. Wedgeplug Valve Co., Div., Stockham Valves & Fittings.

CALGON CORROSION CONTROL PROTECTS THESE VITAL AREAS

Piping, heat exchangers, condensers . . . these are the vital areas where corrosion and other water damage in cooling systems can result in unscheduled downtime, or even force shutdown of the whole process. Costly equipment may be damaged, and production brought to a halt. The losses that can result far outweigh the modest cost of adequate protection.

Call on Calgon Engineering Service to insure protection of the entire system. From cooling towers on through, the Calgon engineer can save you money and time. Experience with every type of water problem in all parts of the country, backed by complete laboratory facilities, is at your service.

Corrosion control with Calgon* is only one of the many services available. A letter or phone call will put a Calgon engineer to work on the solution to your particular water problem.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. Licensed for use under U. S. Patent 2,337,856.

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facts about Superior Packaged Boilers

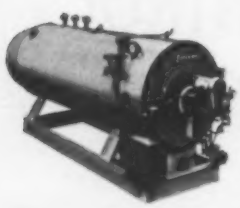
SUPERIOR'S MID-SHELL FURNACE LOCATION

protects against the two most common causes of furnace failure

One of the often overlooked, and yet very important considerations for the purchaser or specifier of boilers of the horizontal fire-tube type is the location of the furnace in relation to the boiler shell. To a great extent this location is determined by whether the boiler is of the up-draft or down-draft type. Up-draft units usually have the furnace set low inside the shell. Down-draft units usually have a higher furnace location.

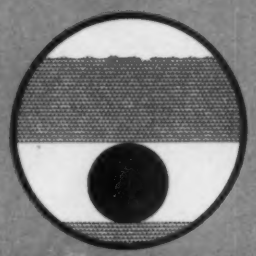
Ideally the furnace is located near the center of the shell, where it is protected from the two most common dangers which can cause bagging, blistering or complete burnout of the furnace.

The first of these dangers is low-water. When the furnace is located too high in the shell, the covering layer of water is necessarily less, and the danger is increased. When the furnace is too low within the shell, mud and silt can deposit on the bottom of the shell and eventually bridge to the bottom of the furnace, cutting off circulation and causing a burnout of the furnace. The adjacent diagrams show the location of the furnace in other fire-tube boilers and in Superior Type C boilers. When you buy or specify a packaged fire-tube boiler consider this important fact.

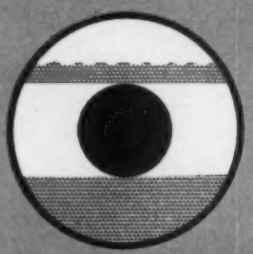


SUPERIOR "TYPE C" PACKAGED BOILERS

Completely packaged fire-tube units for capacities from 20 to 350 bhp. Rotary burners on all sizes. Induced draft for clean, quiet safe operation. Fully insulated and ready for service burning oil, gas or both in combination. Pressures to 250 psi, or for hot water operation. Other fire-tube models for capacities to 600 bhp. Write today for Bulletin 12C.



LOW FURNACE...MUD BURNOUT DANGER



HIGH FURNACE...LOW WATER BURNOUT DANGER

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FUEL BURNING EQUIPMENT

201 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. The Engineer Co.

202 Automatic Fuel Burner — Eight-pp Reference Bulletin 430B describes features and advantages of company's automatic fuel burner. Design and construction details are illustrated and described. Peabody Engineering Corp.

203 For Burning Refuse Fuel — This 8-pp bulletin describes refuse fuel burning equipment, including a pneumatic refuse fuel distributor which spreads refuse fuels such as bark, wood chips, and bagasse uniformly over the grate surface. Discusses various components. Riley Stoker Corp.

204 Water-Cooled Stoker — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

205 Dual-Stage Burners — Bulletin 25 describes an oil burner with two stages of atomization — mechanical and steam. Advantages are fully illustrated and described, and a cutaway view showing component features is included. National Airoil Burner Co., Inc.

206 Spreader Stoker — Catalog 860 contains 20 pp of detailed information on company's overthrow rotor type spreader stoker for boilers of medium size up to 60,000 lb steam per hr capacity. Describes features of design and operation and illustrates applications by means of drawings and installation photos. Detroit Stoker Co.

COAL AND ASH HANDLING

207 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

208 Coal Crusher — Factors to consider in selecting a coal crusher for a particular operation are detailed in 12-pp Bulletin 154. Types of coal crushers and advantages of each are described and capacity and specification data included. Gruendler Crusher & Pulverizer Co.

209 Why Stainless-Clad Steel — Advantages of stainless-clad steel for coal handling equipment are detailed in this 16-pp bulletin. Photo-stories of typical

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applications in hoppers, chutes, bunker noses, pipes and spreaders are included. Lukens Steel Co.

210 Bucket Elevators — Comparison of elevator types and selection of bucket elevators for a variety of applications are covered in 80-pp Catalog be-55. Specifications and dimensions for centrifugal discharge, perfect discharge, continuous bucket, gravity discharge elevator-conveyors, pivoted bucket carrier, bulk cement systems, and marine legs are included, as well as supplementary information on the elevator-lowerator, vertical arm elevator, buckets, bucket punching. Webster Mfg., Inc.

211 Car Dumper — Sixteen-pp illustrated Brochure 957 describes a rotary car dumper capable of handling hopper and gondola cars and equipped with clamps which hold the dumper car without counterweights. These and other design features are explained and installations pictured. Heyl & Patterson, Inc.

BOILERS, GENERATORS

212 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features. Gives dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

213 Boilers for Many Services — This general product data catalog in looseleaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams it provides tabulated engineering data. Industrial Div., American-Standard.

214 Hot Water Boilers — This 20-pp Brochure HCC-2 describes and illustrates design, construction, advantages and economies of the C-E La Mont controlled circulation hot water boiler for supplying high pressure, high temperature water for heating systems and a variety of process applications. Combustion Engineering, Inc.

215 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

216 Standard Generators — Bulletin B-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for industrial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

217 Self-Contained Boilers — Bulletin AD-162, 8 pp, describes company's complete line of self-contained boilers for heating and processing steam or hot water. Design features and advantages are detailed and a cutaway view showing flow

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GILSULATE's low thermal conductivity, low cost and easy installation make it possible for schools, colleges, housing projects, hospitals, industrial plants and other institutions to install central heating with underground piping and to realize the savings in equipment and operating costs which such systems provide.

We'll help you with your plans

If you are planning to rehabilitate present piping, or to install a new underground hot piping system, it will pay you to contact your nearest GILSULATE Distributor. His own extensive experience in the field of heating, piping and air conditioning, plus the research, engineering and field supervision facilities of the American Gilsonite Company are at your disposal...without obligation. They will work with your engineers in checking specifications, unusual soil conditions, and actual installation to make sure that the finished job is completely satisfactory.

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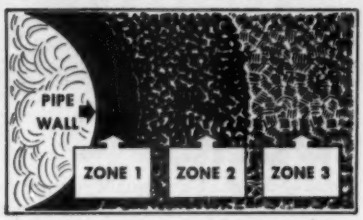
GILSULATE completely frees you of the expensive, time-consuming preparation required by many insulating systems. You just pour it into the pipe trench, shovel-point it around the pipes, and tamp it. Pipe heat does the rest.



Heat fuses the GILSULATE to pipes and joints to form three zones: Zone 1, a flexible, heavy-duty water barrier; Zone 2, of firmly-cemented granular GILSULATE that provides excellent thermal insulation under wet or dry conditions; and Zone 3, which provides a final zone of thermal insulation and a support for the water-proof structure.

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of air in the forced draft system is included. Cleaver-Brooks Co.

218 Packaged Boiler — Bulletin MD156 describes features and advantages of company's line of packaged boilers designed for easy, economical installation. Specifications and dimensional diagrams are included. Murray Iron Works Co.

219 Steam Generator — Sixteen-pp Bulletin M-3A describes features and applications of company's water tube Type CPM steam generator. Complete selection details are given, as well as diagram and principal dimension table. E. Keeler Co.

220 Integral-Furnace Unit — Bulletin G-94 describes the Type PFI integral-furnace boiler, a pressurized-furnace oil- and gas-fired steam generator for power, process or heating loads requiring steam capacities to 400,000 lb-hr. at pressures to 1150 psi and temperatures tp 900 F. Includes information on membrane wall. The Babcock & Wilcox Co.

221 For Low-Pressure Heating — Guide Specifications GS-1, 58 pp, covers underfeed stoker applications to boilers best suited to commercial and industrial heating plants. Includes drawings of flexible layouts of the equipment, as well as specification criteria covering coal and ash handling, boilers, stokers and controls. Bituminous Coal Institute.

WATER CONDITIONING

222 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

223 Coagulant Aids — Featured in this product bulletin is a line of coagulant aids designed to improve floc formation in clarifying and softening water. Advantages are detailed and typical applications described. Calgon Co., Div., Hagan Chemicals & Controls, Inc.

224 Consulting Service — Advantages of company's consulting service are detailed in 8-pp Bulletin 5006-A. How the service is qualified to solve problems concerning scale and corrosion control in boilers, cooling systems, and process waters is discussed. Dearborn Chemical Co.

225 pH and Chlorine Control — The 14th, 1959 edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium magnesium, silica, nitrate, hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

226 Feedwater Heaters—Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

227 Deaerating Heaters — Twelve-pp Bulletin WC-106A on tray type deaerating heaters covers principles of deaeration, tray heater operation, standard heater design and applications, accessory equipment, and design and fabrication of tray utility heaters. A section on design features discusses load variations, installation, metallurgy and construction of trays, and vent condensers. Graver Water Conditioning Co.

TUBING AND ACCESSORIES

228 Heat Exchanger Tubing— Cited in 30-pp Catalog A-205 are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions required it. The International Nickel Co., Inc.

229 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

230 Integral Finned Tube—Detailed information on a line of integral finned tube for heat transfer applications is

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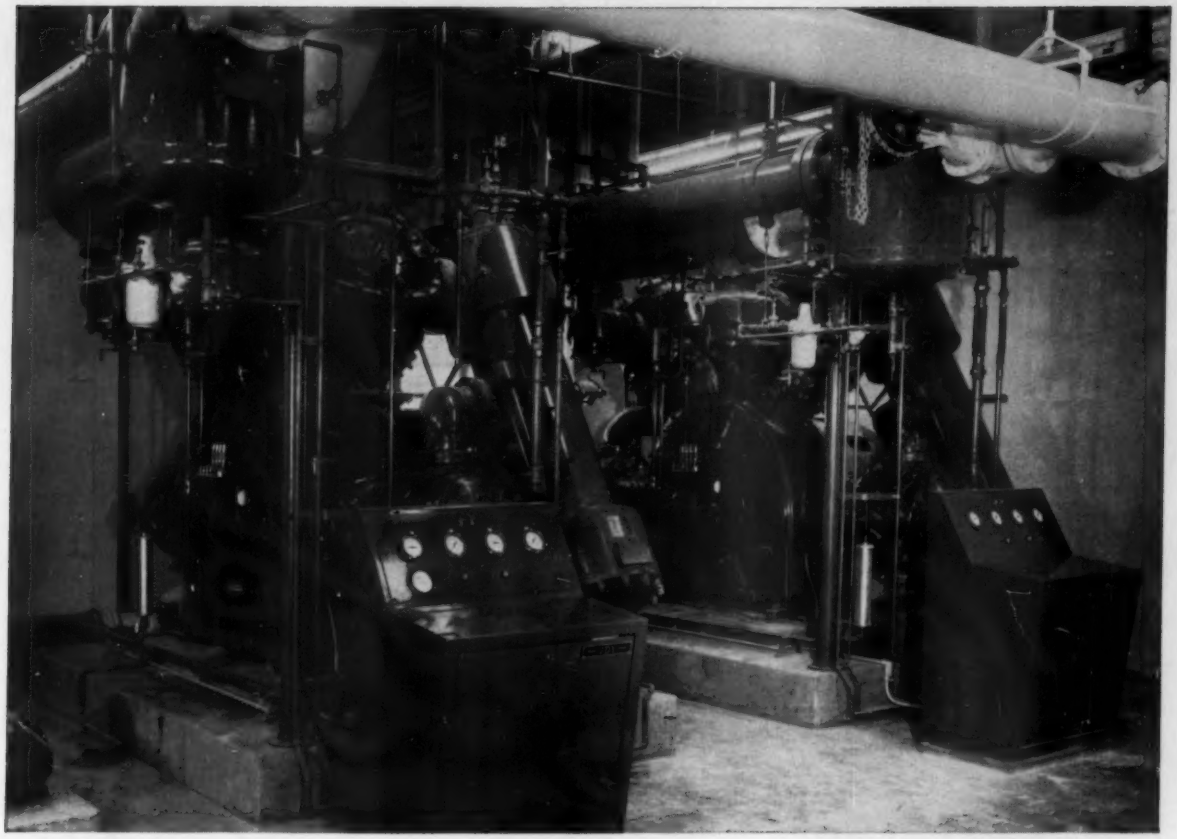

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presented in this 24-pp bulletin. Tables list sizes, alloys, heat transfer data, application data and other information essential for the proper selection of integral finned tubing for a variety of heat transfer applications. Wolverine Tube, Div., Calumet & Hecla, Inc.

231 Electric Tube Cleaners — Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and heat-exchangers. Tables are included giving complete specification details. Elliott Co. Roto Plant, Div. of Carrier Corp.

VALVES, TRAPS, AND PIPING

232 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Edward Valves, Inc.

233 General Service Valves—Twenty-pp Bulletin E-165 is a guide to valves for general services. Types, typical applications, construction and operating features are discussed. Generously illustrated with drawings, photos and cutaways, booklet includes dimensional data. Everlasting Valve Co.

234 Regulating Valves—Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

235 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics covered. Crane Co.

236 Water Hammer Control—Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

237 Reducing Valves—Direct-operated water pressure reducing valves are featured in illustrated Bulletin 1009. A cutaway view showing component features is included, as well as water capacity table, dimensional tables and diagrams. Spence Engineering Co., Inc.

238 For Lightest Condensate Loads — Bulletin T1744 (58) describes company's No. 30 impulse steam trap for use where condensate must be handled in very small amounts. Lists advantages and applications, tells how trap works and gives capacities, dimensions, materials used, prices. Yarnall-Waring Co.

239 Forged Steel Valves — Featured in comprehensive Catalog F-10 is detailed information and engineering data on company's line of forged steel valves, fittings, flanges and unions. Includes photos and

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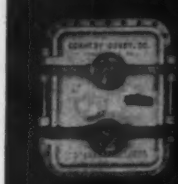

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cutaway views illustrating component features, as well as tables giving dimensional data. An engineering design section with complete specifications and pressure-temperature tables is included. Henry Vogt Machine Co.

240 Steam Traps — Bulletin 455-B describes a float-thermostatic steam trap designed to discharge condensate at steam temperature continuously and without shock. Operation and construction features are outlined, and size and capacity data included. Sarco Co., Inc.

241 Ball Float Traps — Eight-pp Bulletin 2891 describes a line of ball float traps for draining water from air, gas or steam lines, and for draining light liquid from gas under pressure. A section on how to select ball float traps is included. Armstrong Machine Works.

242 Insulated Piping — Described in this 20-pp catalog are prefabricated insulated piping systems for underground and overhead use. Cutaway views showing design and construction features are included, as well as dimensional diagrams and data, and photos of typical applications. Ric-wiL, Inc.

243 Piping for Corrosives — This pamphlet features Jal-Jacket which combines strength of steel with corrosion resistance of unplasticized PVC pipe. Included are lined drawings, pipe specifications, working pressures, temperatures and installations. Jones & Laughlin Steel Corp.

244 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

Postage-free cards for ordering catalogs are on page 129. You may also use the cards to order literature mentioned in the ads.

245 Expansion Joints — Advantages and features of company's line of expansion joints designed to prevent excess stresses due to expansion and contraction, to counteract vibration, and to insulate against noise are detailed in this 12-pp bulletin. Typical expansion joint installations are diagrammed and tables of dimensional data included. Goodall Rubber Co.

ELECTRICAL EQUIPMENT

247 Selecting Protective Devices — The Protection Handbook, 24 pp, is based on the 1956 National Electrical Code, and interprets this code into easily read form. It covers the selection of protective devices for electric circuits, motors, appliances and apparatus, and includes a list showing the size to use when ordinary fuse, Fustron dual-element fuse or Fustat is installed. Book provides wiring diagrams, motor tables. Bussmann Mfg. Co.

248 Testing Instruments — Bulletin 19-58, 16 pp, features company's elec-

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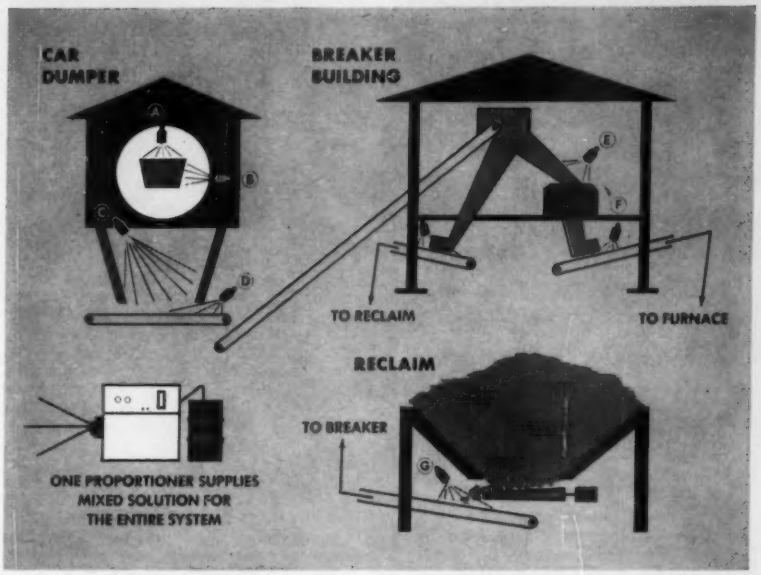

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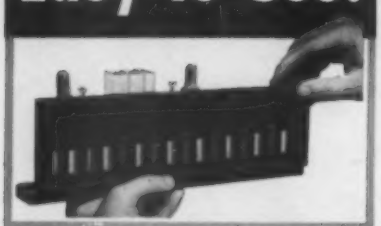

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trical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos of each type. James G. Biddle Co.

MECHANICAL POWER TRANSMISSION

249 Power Transmission Equipment — Bulletin 7900-BIP, 12 pp, is designed as a general catalog on mechanical power transmission equipment. Contains selection charts for heavy duty QD sheaves, light weight and QD Junior sheaves, V-belts, and variable speed drives, including all-speed drives, motor drives, and pulleys. Worthington Corp.

250 Forged Steel Couplings — Self-aligning forged steel couplings designed to transmit maximum torque are described in illustrated Bulletin 450-M67. A cutaway view shows component features, and tables give ratings, sizes. Koppers Co., Inc.

251 Worm Gear Reducers — Complete horsepower and torque data for company's worm gear units built on 2¼ up to 4-in. centers are given in full-page tables in Bulletin 5018. Dimensions are diagrammed and tabulated in detail, and materials and design of interchangeable components are described. De Laval Steam Turbine Co.

252 Industrial Bearings—Comprehensive data on industrial bearings is presented in 80-pp Bulletin A670. Individual sections on pillow blocks, flange bearings, hanger bearings and take-ups give detailed selection and design information. Load rating tables, dimensional diagrams, and sectional views showing component features are included in this illustrated bulletin. Dodge Mfg. Corp.

PUMPS

253 Low Pressure Compressors — Eight-pp Bulletin A-95 describes a line of low pressure compressors for heavy duty industrial applications. Engineering design features are detailed and advantages explained. Joy Mfg. Co.

254 Proportioning Pumps — Catalog 604, 8 pp, covers details and specifications of two mechanical and hydraulic drive metering and proportioning pumps, for precision pumping as low as 11 cc per min, and a chemical pump for systems requiring limited capacities. Advantages are given. Hills-McCanna Co.

255 Controlled Volume Pumps — Bulletin 258 describes Milroyal controlled volume pumps with totally enclosed drives. Discusses design features of the pumps and tells how they work. Also gives specifications. These pumps are designed for metering of chemicals against pressures to 1900 psi in adverse atmospheres. Milton Roy Co.

INSTRUMENTS, CONTROLS

256 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multi-

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point gages and others. Includes descriptive data. Republic Flow Meters Co.

257 Gages, Needle Valves — Catalog 76-G consists of a loose-leaf bound collection of literature on gages and needle valves. Various types of gages are illustrated and described, with applications and specifications fully detailed. A section covers accessories. Jas. P. Marsh Corp.

258 Draft Gages, Instruments— Bulletin 354-B is a condensed catalog giving a briefing on the company's line of stationary and portable draft gages, pitot tubes, air filter gages, gas analyzers, steam calorimeters. Ellison Draft Gage Co., Inc.

259 Resistance Temperature Detectors — In 8-pp Publication 3016D are described a line of remote temperature-sensitive elements for use in indicating, recording, controlling and monitoring equipment. Operations, application and construction details of the resistance temperature detectors are presented. Instrument Div., Thomas A. Edison, Inc.

260 Controls Data — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

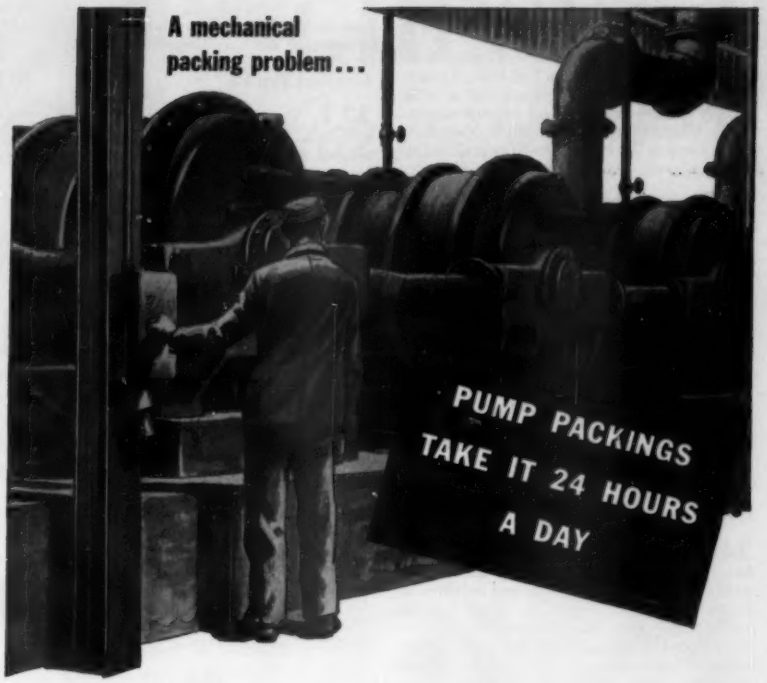
261 Ion-Exchange Controls — Bulletin E-158 describes automatic control systems for ion-exchange equipment. Standards designed to assure proper performance of control units are detailed, and various elements in the control cabinets, as well as the power-operated units, are described. Specifications for electrical controls are also included. Illinois Water Treatment Co.

262 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

263 Metering, Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion of pneumatic and electric telemetering and pneumatic control, along with detailed literature references. Bailey Meter Co.

264 Guide to Gages—Catalog 300-B, 112 pp, features Ashcroft, Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in. Manning, Maxwell & Moore, Inc.

265 Water Columns, Gages — Brochure AO describes water columns, gages and equipment for the low-pressure range (0 to 250 psi). Explains principles and construction of low pressure alarm water columns, and lists accessory equipment. Reliance Gauge Column Co.



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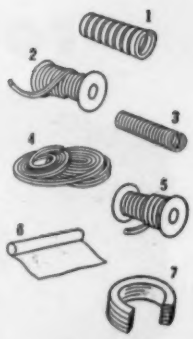

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HEAT EXCHANGING

266 Heat Exchanger — Featured in this 12-pp bulletin is the Fin-Pak, a compact heat exchanger designed for a wide variety of fuel burning and process equipment. Structural details and operating principles are illustrated and typical installations shown. The Air Preheater Corp.

267 Plate Heat Exchanger — Eight-pp Bulletin A-1067 describes applications, dimensions, specifications and features of the plate heat exchangers, available in floor or wall mounted models. Installation photos are included in the bulletin. The De Laval Separator Co.

PACKINGS, GASKETS

268 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

269 Gaskets and O-Rings — Gaskets, back-up rings and O-rings impervious to acids, alkalis, corrosives and solvents at temperatures from −120 to 500 F are described in 6-pp Bulletin P-327. Information includes service and mechanical recommendations, data on operating pressures and standard sizes. Crane Packing Co.

VENTILATING, DUST CONTROL

270 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

271 Ventilation Units—Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data. Buffalo Forge Co.

DUST CONTROL

272 Precipitation Products—Twelve-pp Bulletin G406 contains helpful information on company's various precipitation products, including electrical precipitators, multiclone mechanical dust collectors, combination multiclone-precipitator units, Dualaire filter-type dust collectors and Holo-Flite processors. Also illustrates a number of typical installations. Western Precipitation Corp.

273 Dust Control System — Advantages offered by company's Chem-Jet dust control system for coal handling operations are illustrated and described in this 6-pp bulletin. Principle employed in the system is discussed, also equipment required. Chart shows moisture requirements. Johnson-March Corp.

TOOLS

274 Pneumatic Tools — Featured in Bulletin 67 is a line of pneumatic production equipment, including grinders, sanders, drills, reamers, screwdrivers, nutrunners, filing tools, and cutting tools. Descriptive details and specifications are included. Airetool Mfg. Co.

275 Pneumatic Tools — Described in Catalog PT-58, about 12 pp are portable pneumatic production tools including grinders, attachments and accessories, wire brushes, hose and fittings, air line controls. Provides design features, application suggestions, sizes. Thomas C. Wilson, Inc.

REFRACTORIES, INSULATION

276 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

277 Foam Insulation — Expanded polystyrene insulation for cold storage applications is featured in this illlustrated bulletin. Method of application is shown, and physical and thermal properties of the material listed. Johns-Manville.

278 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, fittings. Union Asbestos & Rubber Co.

279 Duct Insulation — Spun mineral wool duct insulation is illustrated and described in this product bulletin. Advantages are listed and data on thermal con-

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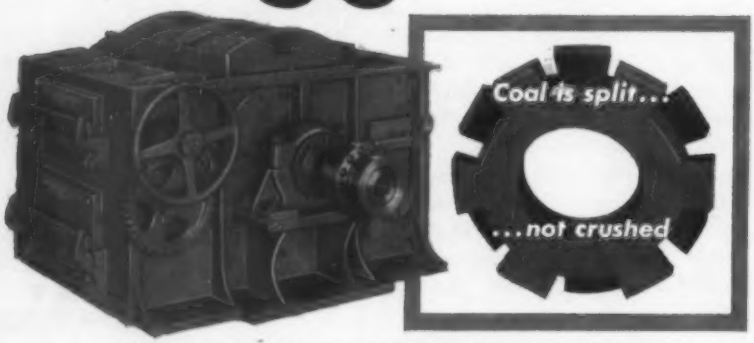

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ductivity and sound absorption characteristics tabulated. Standard application procedures are described. Baldwin-Hill Co.

280 Mineral Insulation — Properties and characteristics of Gilsulate and its applications as a material for insulation and protection of underground hot pipes and systems are described in this illustrated booklet. Table of specifications is included. American Gilsonite Co.

281 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing: also information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Div., United States Steel Corp.

282 Refractory Mortars—Six-pp Bulletin 600 covers the refractory mortars manufactured by this company. Included are installation photos, product features and technical data containing recommended maximum use temperatures, fusion, types of set, form, pounds required per 1000 brick for trowelling, dipping and brushcoating as well as gal of water required to trowel and dip the mortars. J. H. France Refractories Co.

OTHER EQUIPMENT

283 For Quiet Heating — Described in this bulletin is the HusHeater, designed to heat — without making a sound — water and liquids by introduction of steam into the liquid. Lists advantages of the HusHeater. Most common application is in filter boxes and hotwells. Sims Pump Valve Co. Inc.

284 Process Equipment — Bulletin G-3B describes equipment for process industries, including pneumatic conveying systems, compressors and vacuum pumps, coolers and preheaters, blowers, gas and vacuum pumps, fans and gas washers, accessories. In addition to describing features and advantages of the equipment, including engineering data. Fuller Co.

286 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plant installations. Connery Construction Co.

287 Soot Blowing System — Described in 16-pp Bulletin 1029 is an automatic soot blowing system for control of boiler cleaning. Covers two basic control systems — automatic selective-sequence and automatic sequential, with complete controls, interlocks and protective devices. Copes-Vulcan Div., Blaw-Knox Co.

288 Generating Set — Bulletin 109 describes a power-producing unit which can be used to advantage in any one of four ways in each of which by-product power is developed. Tables of ratings and data are included. Troy Engine & Machine Co.

289 Automatic Data Systems — Described in Bulletin MSP-154 are electronic data handling systems for logging, monitoring, and integration of process

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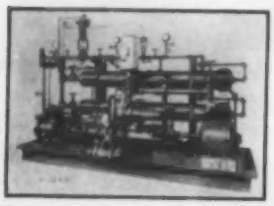

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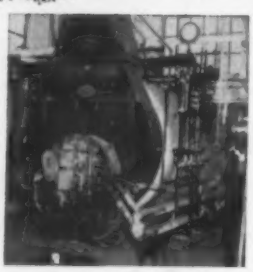

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information. Discusses basic design parameters, programming, switching, analog to digital conversion, linearization, calibration, digital ranging, print-out and off-normal alarms, remote switching, digital variable indication, integration, computation. Hagan Chemicals & Controls, Inc.

290 Cooling Towers — Performance details on company's cross-flow cooling towers are presented in this 20-pp illustrated booklet. Discusses and illustrates through diagrams the cross-flow principle of water cooling, and includes descriptions of equipment, engineering and design features. The Marley Co.

291 Plumbing, Heating Supplies — Edition H is the current edition of this company's 126-pp general catalog on plumbing and heating repair parts, tools and accessories. Indexed and illustrated, the catalog gives information on uses. J. A. Sexauer Mfg. Co., Inc.

292 Laboratory Supplies — This 12 pp price list announces latest prices for a wide range of laboratory supply items, including water analysis sets, conductivity equipment, colorimetric comparators, glassware and supplies, chemical reagents, and company's photometer with replacement accessories. Betz Laboratories, Inc.

293 On Model Studies — Advantages of model studies for precipitators and other gas handling systems are presented in this 18-pp brochure. Discusses three plans under which this new engineering service is available. Several case histories are detailed to show benefits obtained. Also provided are articles on the subject reprinted from POWER ENGINEERING and other publications. Research-Cottrell, Inc.

295 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

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297 Cranes, Hydro Equipment — Twelve-pp Brochure HY-51 describes cranes and equipment for hydroelectric, water supply and other applications. Various components and assemblies that help harness hydroelectric power are pictured, including cranes and hoists, gates and valves, and special hydroelectric equipment. Yuba Consolidated Industries, Inc.

298 Is Salt Just Salt? — This is the title of an 8-pp bulletin describing salt characteristics and properties as well as geographical distribution. Variations in salt from different areas in the United States are illustrated and company's refined products described. Morton Salt Co.

299 Safety Grating — Features and advantages of company's steel, aluminum and stainless steel safety grating are illustrated and described in 24-pp Catalog 5911. Describes types of loading and includes load charts. The Globe Co.

"push button" access locks eliminate human error

Henry Pratt access locks at MIT Test Reactor

Absolute integrity is assured any Nuclear Reactor Containment Vessel when Henry Pratt Co. Access Locks are provided. Completely automatic, these unique safety devices are interlocked so that entrance and exit to the vessel is accomplished with ease, in 25 seconds, with complete safety.

The knowledge and experience gained through installations at Vallecitos (GETR), Arco (EBR-2), M.I.T. (test reactor), Ispra, Italy (CNRN) and others, has enabled the Henry Pratt Co. to offer a complete line of standard sizes for both personnel and equipment in high pressure and low pressure design.

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1 Inflatable Seal Personnel Air Locks. Either round or rectangular. Only one second is required to inflate or deflate the seal from readily available plant air supply. Emergency inflation can be provided by standby nitrogen tanks or air reservoirs. Push button actuated, only proper sequence of buttons will operate doors. Eliminates error. Flush-floor doors for easy passage of personnel or hand-trucks. Features pressure equalizing valves which prevent radical pressure changes within lock.

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The Henry Pratt Co. is also a pioneer in the design and manufacture of butterfly valves and expansion joints for the Nuclear Industry. A competent group of sales engineers are located in key cities. In Europe, represented by Ateliers J. Hanrez, Societe Anonyme, Monceau-sur-Sambre, Belgium.

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HENRY PRATT

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Continued from page 96

flowing currents for condensing water purposes. It's being done by building intake structures, or "skimmer walls," which admit only the cold waters.

L. H. Carr of Edward Valves, Inc explained how modern low-pressure-drop valves and other feedwater piping equipment take advantage of higher feedwater velocities with smaller feedwater line sizes. These smaller line sizes can appreciably reduce over-all capital cost of modern power generating units.

With the coming of the nuclear power plant and the once-through boiler, great interest has arisen in the problem of dumping large quantities of steam into condensers. R. A. Wilson of Allis-Chalmers reviewed the history of this problem, and also described the dumping arrangements being used today in nuclear power plants and for once-through boilers.

Fuel Problems

This session heard an evaluation of coal sampling procedures by W. W. Anderson of Commercial Testing and Engineering Co. Pointing out that a means of measurement of sampling characteristics of coal has been tentatively accepted within the working groups of the International Organization for Standardization, he discussed an index of variability, provided in this method, known as variance. This takes account of moisture, ash, Btu, volatile matter, and all the other analytical characteristics; and this variability can be expressed by a numerical value. He showed a number of charts of these variances for different coals and explained their value in sampling.

Howard L. McNally, of Dow Chemical Co, explained how Dow produces lightweight concrete aggregate from molten boiler slag.

Another paper by W. W. Hagnauer of Commonwealth Edison Co and K. W. Hamming of Sargent & Lundy covered generating station coal bunker explosions.

Important factors, among others, are insuring a smooth flow of coal through all sections of the bunker and eliminating possible pockets for lighter-than-air gases, such as methane.

Long-Range Goals

John C. R. Kelly, Jr. of Westinghouse Research Laboratories explained the present status and future prospects of direct conversion of heat to electric power. After explaining the early discoveries in thermoelectricity as far back as Seebeck in 1822, he showed that the thermodynamic cycle efficiency can compare very favorably with that of the turbine generator because the former can sustain much higher temperatures.

Leonard J. Linde of Allis-Chalmers and RCA described the principles and the work being done on the Stellarator at Princeton. This machine is designed for research in thermonuclear fusion. This process has already been explained in the ATOMICS section of POWER ENGINEERING and the paper will be published in the June ATOMICS section.

Four years' experience with stainless steel condenser tubes was reviewed by John C. Coackley of Carpenter Steel Co. W. A. Pollock of Wisconsin Electric Power Co reported on experience with aluminum condenser tubes, supplementing a previous report.

Development and tests of a new analyzer for continuous analysis of dissolved oxygen in water was discussed by Wright and Lindsay of Westinghouse's Bettis Plant.

New system for completely automatic chemical analysis of boiler and condensate waters in power plants was described by Ferrari and Catanzaro of Technicon Instruments Corp.

High-Voltage Circuit Breakers

Largest single class of applications for high-voltage vacuum power circuit breakers so far has been in the field of capacitor switching, said J. W. Rittenhouse of Hi-Voltage Equipment Co. A vacuum breaker with a steady state interrupting capacity of 4000 amp and from 34.5 kv up has been developed.

Satisfactory design and operation of a 15-kv capacitor switch employing vacuum interrupters were detailed by Balfour of Louisiana Power

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VALVES ARE GUARANTEED to last longer in any pump

HERE'S HOW...

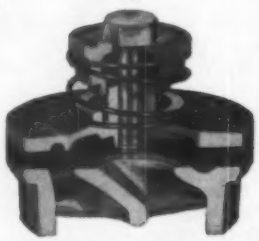
Stem breakage eliminated – by exclusive double shock-absorber stem heads.

Reduced wear – long guide gives even lift. Springs can't jam.

Smooth seating surface – rotating valve disc changes to new seating surface with every pump stroke.

Reduced flow resistance – accomplished by Sims inclined seat-ribs.

Sims Pump Valves, for all reciprocating pumps, are stocked for quick delivery.



Write for Bulletin V-112 explaining how Sims Valves can improve your pump operation at lower cost.

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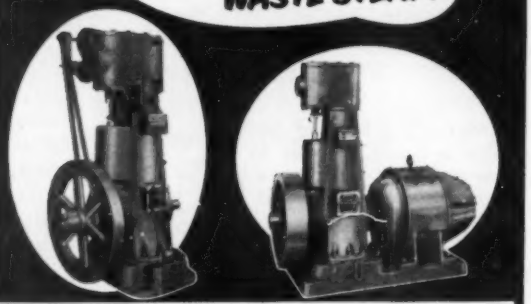

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Save dollars with "by-product" power from waste steam used for processing or heating—Generating low-cost electric power or drive stokers, fans, pumps, compressors, and other plant equipment. Efficient even against high back pressure.

Type E. Steam Engine, 12½ hp. to 100 hp.

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Complete units A.C. or D.C., vertical and horizontal. Capacities up to 60 KW and 94 KVA. Reduces costs for power by eliminating premium rates. Essential source of stand-by power.

Investigate this source of cheaper power for your plant.

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Bulletins 109 AC, 110 DC—Generator sets

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& Light Co and Pflanz and Lester of Allis-Chalmers.

Air-blast circuit-breakers for voltages from 115 kv through 460 kv, of building block design, with accessories, were discussed by Wilson and Shores of General Electric Co. They claimed advantages over oil breakers, such as elimination of fire hazard, short arc duration, easier maintenance, reduced cost of parts, storage and handling, and several others.

Gas-filled, high-voltage high-capacity circuit breakers for 115 kv to 460 kv, using sulfur hexafluoride as a dielectric and interrupting medium, were explained by R. E. Friedrich of Westinghouse.

EHV Systems

Present development of extra-high-voltage lines was described, in turn, by speakers from Russia, Canada and the United States. B. P. Lebedev, USSR Ministry of Power Stations, stated that Russia is increasing its 400-kv lines to 500 kv, based on operational data obtained to date. Future lines in this range will all be designed for 500 kv, to transmit greater loads at great distances more economically.

Next, and of particular interest to POWER ENGINEERING, was the paper presented by H. W. Haberl of Hydro-Quebec. (In the April, 1959 issue, an article on EHV lines referred to some of the lines discussed by Mr. Haberl.)

The 300-kv system, from Bersimis hydro to Quebec City, then on to Montreal, was described in this session.

Ohio Edison Co's 345-kv system was described in a paper by Lynn Firestone and E. A. Rothfus. In the past, the loads served and distances involved, prescribed an upper voltage limit of 138 kv. However, extensive studies now indicate that all future EHV lines will be 345-kv, two-wire bundled conductors, on steel towers.

Electrical Industrial Session

To train men for the servicing of complicated electrical controls now used on production equipment, three speakers told of their companies' training programs in this field, Norman Cutliff, of International Harvester's Memphis plant, told of their selective employment technique, on-the-job training, and probationary period.

This program consists of a total of 8000 hours of mixed classroom and working training.

General Motors' centralized program, conducted at the GM Institute, was described by M. A. Jacobs, of A-C Spark Plug Division of GM Co. Selected trainees are given a concentrated course at the Institute, consisting of 40 hours each, in classroom and in a specially designed laboratory.

A completely different type of training was described by A. Swatek, electrical engineer at Inland Steel Co. This sytem is essentially a college-level extension course, conducted by Purdue University's Calumet Extension.

N. H. Erlandson, Carolina Power and Light Co, gave a most interesting talk on their experiences with a 115-kv line conductor addition project.

The project involved two phases: 1. to reconductor 23 miles of line; and, 2. to reinstall 23 miles of conductor with existing conductor of the same type to form bundled construction.

Experience with polyethylene, as insulation on 35-kv cable, was discussed by G. J. Crowdes, Simplex Wire and Cable Co.

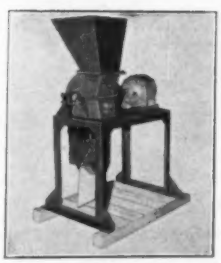
Peaking Service

B. H. Hefner and B. B. Brownell of GM's Electromotive Div told of their company's experience in the field of automatic diesel generating units and stated that a production-line set-up was now producing standard size units on relatively short-time delivery.

In behalf of gas turbines, A. O. White of G-E gave a paper prepared by R. J. Carpenter, W. D. Marsh, and himself. This paper described the extent to which gas turbines had been developed especially for peaking service by G-E. Plant building construction costs are minimized by the small floor area required — about one-third that required by the equivalent steam turbine — while the savings in installed cost should be about 15 to 30 per cent. THE END

What can new Morton LEVETROL do for you? Read all about it next month.

HOW TO SELECT YOUR COAL CRUSHER



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To help you select the right crusher for the right job, a brochure entitled "How to Select Your Coal Crusher" may be had for the asking. It answers many questions about Coal Crushers and will prove invaluable when determining the crusher best suited for your needs . . . ideal information for consulting engineers. The various types of crushers are illustrated, together with their specifications and capacities. Write for your copy today.

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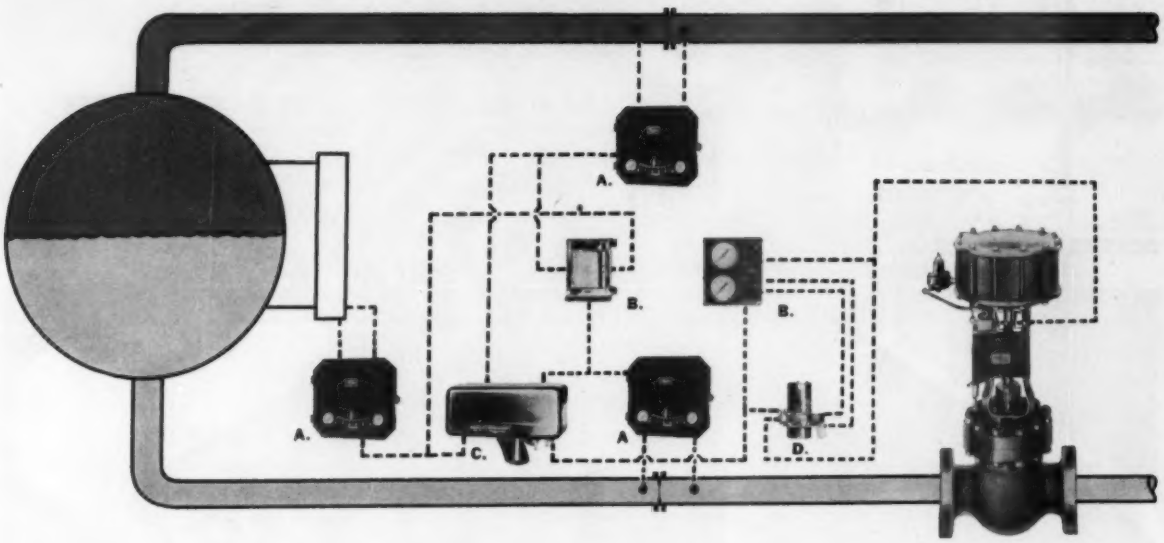
How Copes-Vulcan control systems boost power plant efficiency



Copes Feedwater Control brings stability to high-duty steam generators

To meet the higher ratings and fast load changes of today's boilers, Copes Type 3-L Feedwater Control combines the dynamic balance of custom-engineered control valves with precision-built instruments.

Feed to the boiler is modulated by steam flow, feedwater flow and drum water level. Feedwater input closely matches steam output on constant or varying loads. A stabilized water level is maintained regardless of changes in load or feed pressure, and while blowing down or blowing soot.

A complete line . . . a complete service

Over 50 years of design experience backs Copes-Vulcan's broad line of control systems for boiler cleaning, combustion, feedwater, pressure reducing and desuperheating operations.

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A. Indicating transmitters send water level and flow influences to the computing relay where steam-flow and water-flow are accurately balanced.

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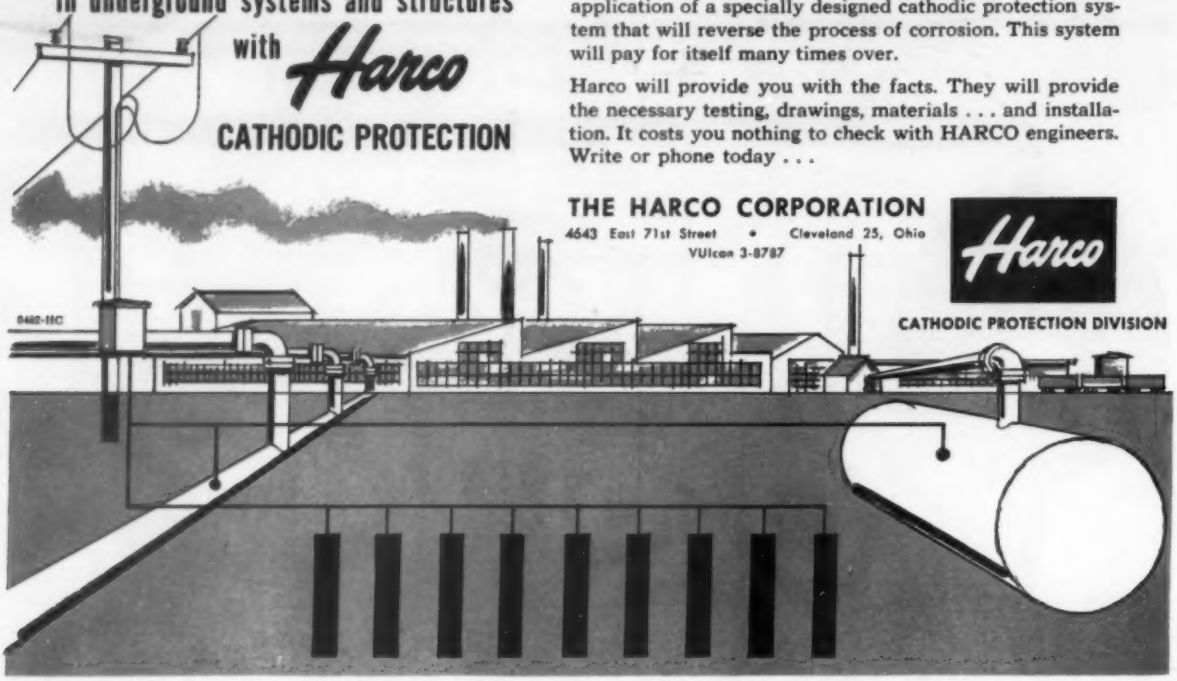
in underground systems and structures with *Harco* CATHODIC PROTECTION



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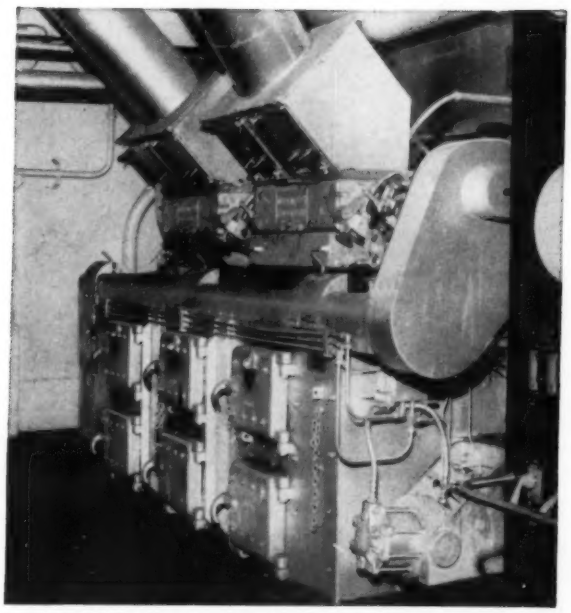
(Wide World Photo)

SS EDMUND FITZGERALD...

the 61st Ship equipped with

DETROIT STOKERS



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The Str. Edmund Fitzgerald, with Detroit RotoStokers Type CC (continuous cleaning), is the 61st ship in 10 of the Great Lakes fleets to be equipped with Detroit Stokers.

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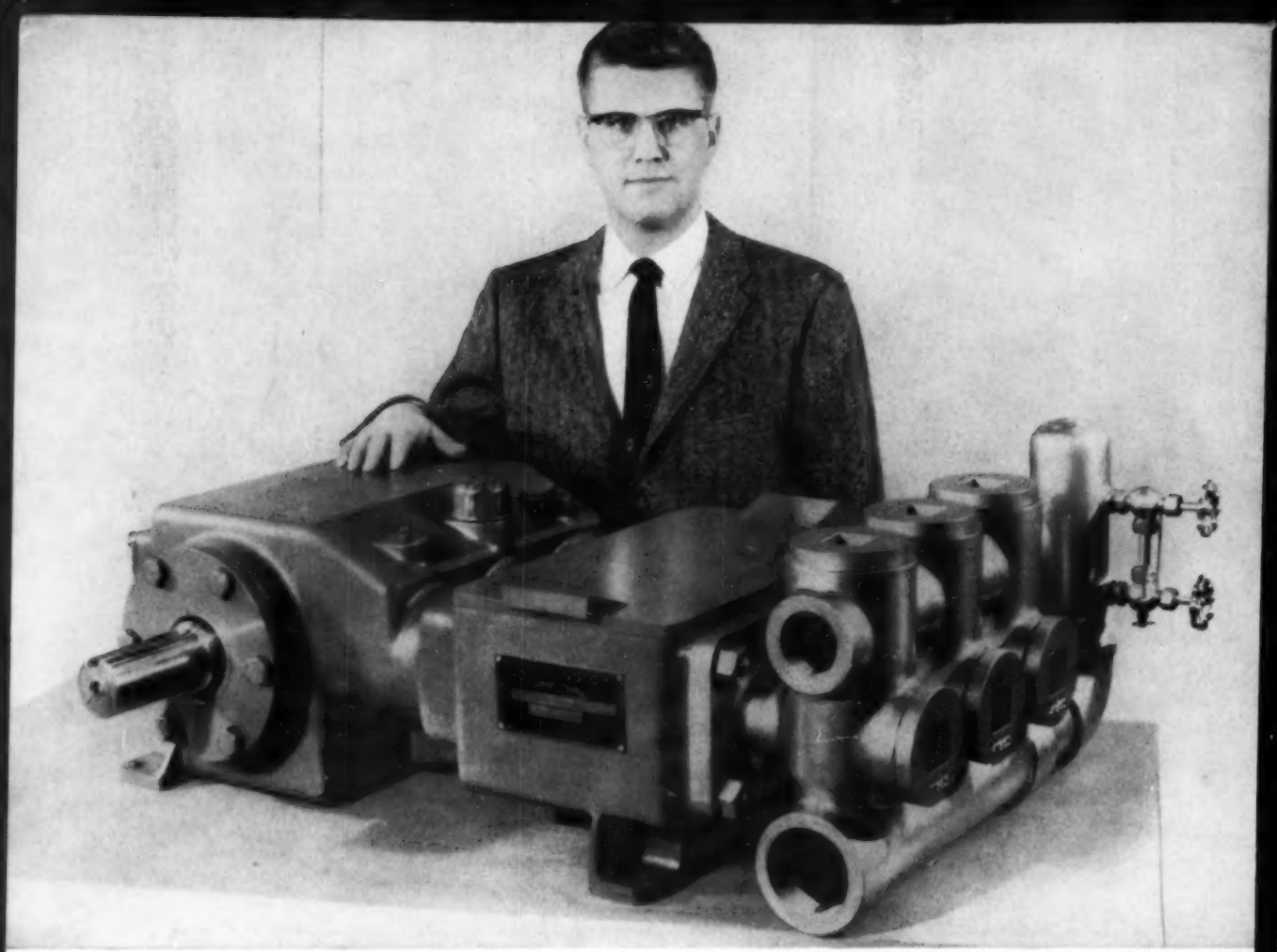
MAIN OFFICE AND WORKS • MONROE, MICHIGAN

District Offices or Representatives in Principal Cities

For more data circle 589 on Post Card



NOW! A HIGH PRESSURE PUMP AT A NEW LOW PRICE

Before you buy a high pressure pump for accumulator systems or other hydraulic applications, you should see the new Worthington KCA. On any problem requiring reliable high pressure, you can depend on the KCA to give you: highest capacity of *all* comparable competitive models, more pressure, and a truly low price. Charts below prove it. You get fully 23% more gallons capacity per day. You get at least 100 psi more than the next best pump. And your cost per input horsepower is only $38.

Check these 5 extra economy and efficiency features yourself:

1. **High volumetric efficiency** made possible by straight-flow design and "close-clearance" liquid end construction.

2. **Maximum stuffing-box accessibility** due to lack of partitions in power end cradle.

3. **Many "extras" included as standard** such as suction air chamber to minimize noise and pulsation, plunger packing and stuffing box cover.

4. **Flooded suction adequate** because large pipe connections minimize friction. 3" suction, 2" discharge on either side.

5. **Less valve wear** resulting from guided, wing-type valves that are self-grinding. Liberally-sized suction and discharge valves both removable through single top covers.

Some of the many applications for the new KCA pump include hydraulic presses and shears, steel mill roll balance, die casting, boiler feed service, descaling, cleaning and washing, fog spraying, hydrostatic testing, and rifle drilling coolants.

For complete details, contact your nearest Worthington district office. Or, if you prefer, write: Worthington Corporation, Section 32-3, Harrison, New Jersey. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

HIGHEST CAPACITY

Worthington KCA	98600
Brand A	78120
Brand B	66780
Brand C	54000
[illegible]	44310

MAXIMUM CAPACITY IN GALLONS PER DAY*

*At normal ratings. Some manufacturers, including Worthington, will permit higher speeds, capacity and horsepower after approving suction conditions. Best performance, however, is obtained by staying within normal ratings.

MOST PRESSURE

Worthington KCA	3100
Brand A	3000
Brand B	3050
Brand C	1490
Brand D	1550

MAXIMUM PRESSURE–PSI

LOW COST

Worthington KCA	$38
Brand A	35
Brand B	46
Brand C	58
Brand D	47

COST PER INPUT HORSEPOWER–NORMAL RATINGS